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PRINCIPAL INVESTIGATOR: Jay B. Roberts
Ashok Bapat, Ph.D., MBA

CONTRACTING ORGANIZATION: Saint Francis University
Loretto, PA 15940

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6. AUTHOR(S)
Jay B. Roberts
Ashok Bapat, Ph.D., MBA

Email: jroberts@cermusa.francis.edu

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
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14. ABSTRACT
Appropriate healthcare services remain a major challenge for rural America. Underdeveloped infrastructure and lack of well qualified healthcare providers including specialists remain the major root causes. Factors such as geography and race contribute to the disparities in proper and adequate medical services. A number of rural hospitals have been operating without modern facilities. Less than 10% of the country's physicians and specialists practice in rural areas. The spending on Medicare and Medicaid services which has increased from $370 billion in 2001 to $477 billion in 2004 is the living testimony in support of high cost of medical services. It is clear that spending more money is not enough to solve all the healthcare problems. The lack of good healthcare systems is impeding their economic growth. Thus rural regions continue to face unprecedented and great challenges. For the past eight years, CERMUSA through its initiatives has been helping the rural hospitals to establish an infrastructure to enable them to provide modern care and education to their clients, employees, and healthcare professionals. It is helping them to generate a network of healthcare providers to fulfill the unmet need of a robust and vibrant healthcare center in remote and rural western Pennsylvania.

15. SUBJECT TERMS
Telemedicine, Telehealth, Mesh Networking, Distance Learning, Distance Education, Assistive Technology, Internet2, Off-the-shelf Technology

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FY05 Research Summary

Appropriate healthcare service access remains a challenge in rural America. Technical advances have helped larger cities to become centers of modern medicine at the expense of rural and remote regions of the country. Sparse population, lack of necessary infrastructure and poor economic growth have prevented major medical service providers, including well qualified physicians and medical specialists, from providing the same level of care available in metropolitan areas. As a result, rural communities find it difficult to recruit businesses and promote economic growth. In addition, out-of-control healthcare cost increases make the situation worse for the rural regions, as is evidenced by increases in spending on Medicare and Medicaid services from ~\$370 billion in 2001 to ~\$477 billion in 2004 (Centers for Medicare and Medicaid Services. CMS Financial Data. 2004 www.cms.hhs.gov/researchers/walletcard/04cmsfinancialdata.pdf). It is also important to note that factors such as geography and race contribute to the disparities in proper and adequate healthcare services. Rural areas face the greatest challenge because of a lack of healthcare providers. Less than 10% of the country's physicians and specialists practice in rural areas (US Dept Health and Human Services, *National Healthcare Disparities Report*, 2004). In spite of increasing healthcare expenditures, the evidence clearly indicates that spending more money does not solve the healthcare problems within the United States. Healthcare providers and policy makers are looking at ways to reduce this gap. In recent years, reduced cost and easy access to the communication technologies have prompted their use to deliver healthcare to remote areas, and as a result they are becoming a substantial part of a viable solution to above-mentioned problems.

Innovative and interdisciplinary approaches for efficient and productive delivery for quality health are necessary. For the past thirteen years, the Center of Excellence for Remote and Under-Served Areas (CERMUSA) has explored ways to deliver quality healthcare to rural, western Pennsylvania. CERMUSA uses commercially available off-the-shelf technologies (COTS), adapts the equipment to address the identified needs with the goal of enhancing access to healthcare and education in remote, and under-served areas. The modifications allow cost-effective and sustainable methods for reaching the rural communities. Our successes, failures, and lessons learned allow CERMUSA to plan, develop, implement, and evaluate the modifications that suit our needs. To provide efficient and high-quality healthcare delivery processes, telemedicine solutions need to be novel and interdisciplinary. In recent years several organizations have begun to provide telepsychiatric therapy, teleradiology, and in some instances telehomecare. In coming years the list of services will continue to grow.

An eye hospital in the Netherlands has been providing teleopthalmological services to optometrists and patients (J. Telemedicine Telecare 2004, **10**:331-36). Similarly, nurses advise patients with medical surgery problems (J Nursing Research. 2002; **24**:583-90), monitor aging patients (J. Telemedicine Telecare, 2001, **7 (supplement 1**):76-77), and mediate consults (Clemens, CM et al. Understanding health communications technologies, San Fransisco: Jossey-Bass; 2004:111-17). A number of medical center-based programs have taken note of these developments and are working to deliver specialized telecare to distant and remote areas (J American Board of Family Practice, 2002 15:123-27; Professional Psychology Research Proceedings, 2005, **36**:158-63). In short, telemedicine is emerging as a technology capable of enhancing healthcare.

One of the important aspects of telemedicine is the capability of the communications infrastructure to deliver the services. This will require extensive use of wireless and other emerging technologies to reach the homes of prospective patients. Network time delay and other quality of service issues could be potential critical concerns. This may require new network transport protocols to cope with time delays, video jitters, and packet loss in order to better facilitate real-time data transmission over the Internet. These improvements will certainly lead to increased healthcare effectiveness, reduced cost-of-care services, improved mobility and flexibility to the healthcare providers, and would potentially advocate healthy and active life styles.

During the past year, CERMUSA undertook several studies to address some of the important issues that are critical for easy access to healthcare services. A component of telemedicine is the ability to provide proper training or continuing education to rural healthcare practitioners such as physicians and pharmacists. A robust communications platform or system is important for this purpose. CERMUSA has tried to establish such a communications network. This report is a result of some of the initiatives undertaken. The studies that we have completed or proposed offer flexibility for the end-user (e.g. patient) as well as the healthcare provider. CERMUSA, through its distance learning paradigm, has provided healthcare education that has enabled pharmacists and other medical personnel to stay current with the advances in the field. Although many of our studies did not begin in a timely manner due to administrative issues, the ones that are complete clearly show that the use of technology as a viable method to manage healthcare for patients and continuing education for service providers. This method could allow the healthcare professional to monitor such a patient if appropriate equipment is available. CERMUSA continues to develop and improve ways that will allow such care. CERMUSA continues to explore the wireless test bed for its robust and rugged design. One of our distance learning studies compared several learning management systems (LMS) and determined that there is no such thing as a complete LMS that can fulfill all the requirements of a classroom environment.

CERMUSA initiated several new studies such as the use of robotics for neuro-rehabilitation, use of video technology for wound-care management, and telerehabilitation services for returning casualties of war. In a number of instances, IRB issues delayed the start of the studies. By the time these issues were resolved, the window of opportunity had passed for some. This has forced CERMUSA to continue the studies in the upcoming year. A study that addressed returning casualties was cancelled due to lack of a willing partner.

The significance of our studies is far reaching. During the course of international confrontations, the paradigms that we have developed to address issues such as telerehabilitation and distance education could be adapted for the military personnel who may not have any means to attend classes, or delivering healthcare to the areas which are hard to serve such as the front line. Thus, the applications could reach rural areas of Pennsylvania as well as the theatre where troops may not have an easy access to quality education and healthcare.

In the years ahead, CERMUSA using telehealth and distance learning paradigms will continue to explore ways to include hard-to-reach areas through innovative modifications and easy-to-use methods. Additionally, it will continue to explore ways that will allow monitoring of patients and provide consultations with well-known specialists without leaving their familiar environment, and educate medical personnel using distance learning protocols established here.

FY05 Staffing List

CERMUSA FY05 STAFFING LIST

STAFF MEMBER	ROLE
Kristine M. Anderson	Distributed Learning Course Management Specialist
Dr. Ashok Bapat (hire date 6/26/06)	Senior Scientist
Kourosh Barati	Senior Programmer/Systems Analyst
Thomas J. Bender	Communications Platform Technology Manager
Steven A. Bickford	Telemedicine Handheld Computing Specialist
Gabrielle M. Cronin	Instructional Designer
Barbara R. Demuth	Assistant Director for Telehealth
Robert A. Dillon	Information Technology Systems Engineer
Mary Fuska	(NTSS) Telehealth Technology Coordinator
Lisa A. Gaston	Departmental Office Assistant/Receptionist (TM/IT)
James F. Gerraughty	Electronic Classroom/Video Production Manager
Robert E. Griffin	Assistant Director for Distance Learning
Brenda Guzic (hire date 6/26/06)	Telehealth Development Specialist
Grace B. Haid (termination date 4/17/06)	Departmental Office Assistant/Receptionist (DL)
Jean Kline (hire date 5/22/06)	Departmental Office Assistant/Receptionist (DL)
Dawna R. Knee	Technology Coordinator
Gina L. Litzinger	Telehealth Development Specialist
Robert W. Mainhart	Program Manager
James W. Makin	Technology Support Specialist
Lori A. McClellan	NTSS Secretary
Eric S. Muncert	NTSS Site Manager
Stacy A. Novak (termination date 5/18/06)	Telehealth Development Specialist
Dana M. Parrish-Friedman	Technology Coordinator
Vicki A. Pendleton	Telehealth Development Specialist
Darlene E. Prosser	Receptionist/Office Assistant
Michael P. Reigh	Production Assistant
Jay B. Roberts	Director
Mary Jane Rowland	Business Case Prototype Manager
Michael E. Shanafelt	Senior Information Technology Advisor

Jacob Taylor	Information Technology Systems Administrator
Kent P. Tonkin	Assistant Director for Information Technology
Camille M. Wendekier	Telehealth Development Specialist
David M. Wolfe	Wireless Communications Specialist
Bernadette A. Yeager	Research Logistics Specialist
Bonnie Pepon	Diabetes Research Analyst
John Miko	Application Development Specialist
Brandon Nee	Graduate Assistant
Jonathan Miller	Work Study Student
Julie Ropp (termination date 1/5/07)	Work Study Student
Hannah Thompson (termination date 8/25/06)	Work Study Student
Megan Yeager	Work Study Student

Publications and Presentations

Saint Francis University
CERMUSA FY05 Publications and Presentations
January 2006 to January 2007
(listed most recent first)

Rural Health Publications (5)

National Telerehabilitation Service System Newsletter. (December 2006). Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas, (Vol. 5, Issue 3).

National Telerehabilitation Service System Newsletter. (August 2006). Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas, (Vol. 5, Issue 2).

McClellan, L. (NTSS Secretary). (April 2006). National Telerehabilitation Service System Helping Rural Under-Served Communities and Individuals with Disabilities. *Exceptional Parent, 36*(4), 47-49.

National Telerehabilitation Service System Newsletter. (April 2006). Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas, (Vol. 5, Issue 1).

Griffin, R., Parrish, D., & Reigh, M. (2006) Using Virtual Classroom Tools In Distance Learning: Can The Classroom Be Re-created At A Distance? *Imagery and Artistry Animating the Mind's Eye (Selected Readings of the International Visual Literacy Association.* Page, 79.

Rural Health Presentations (37)

Holiday Traditions Conference – Interactive Videoconference via Internet2, (2006, December 15). Loretto, PA: CERMUSA/SFU

Tonkin, K. (Assistant Director for Information Technology) & Donovan, J. (SFU faculty member). (2006, December 5). *Internet2 and Collaboration in Music Classes in Liberal Arts Colleges ** Music from the Mountains: Providing Live Arts Education From a Small Rural University.* Fall 2006 Internet2 Member Meeting, Chicago, IL: CERMUSA.

Tonkin, K. (Assistant Director for Information Technology), Makin, J. (Technology Support Specialist), & Wolfe, D. (Wireless Communications Specialist). (2006, November 21). *Off-road Computing: How to Build a Wireless Network Almost Anywhere!* SFU Science Day 2006 Presentation, Loretto, PA: CERMUSA.

Gerraughty, J. (Electronic Classroom/Video Production Manager). (2006, November 21). *Internet2: Bringing Science into your Classroom.* SFU Science Day 2006 Presentation, Loretto, PA: CERMUSA.

Shanafelt, M. (Senior Information Technology Advisor), & Miller, J. (Student Assistant). (2006, November 21). *GIS: Using Google Earth to Make a 3D Model of Saint Francis University.* SFU Science Day 2006 Presentation, Loretto, PA: CERMUSA.

Shanafelt, M. (Senior Information Technology Advisor), & Miller, J. (Student Assistant). (2006, November 16). *Creating a 3D Model Using Google Earth.* Presentation to Association of Information Technology Professionals, Johnstown, PA: CERMUSA.

National Telerehabilitation Service System (NTSS). Assistive Technology Exposition, (2006, November 15). Johnstown, PA: CERMUSA/NTSS

Pendleton, V. (Telehealth Development Specialist). (2006, November 8). *Telehealth and Nursing*. Presentation to Nursing Students at the University of Pittsburgh at Johnstown, Johnstown, PA: CERMUSA.

Pendleton, V. (Telehealth Development Specialist) & Tonkin, K. (Assistant Director for Information Technology). (2006, November 5). *Telehealth and Technology*. Presentation to Southern Alleghenies Planning and Development Commission, Altoona, PA: CERMUSA.

Roberts, J. (Director), Bapat, A. (Senior Scientist), Demuth, B. (Assistant Director for Telehealth), Griffin, R. (Assistant Director for Distance Learning), & Tonkin, K. (Assistant Director for Information Technology). (2006, August 23). *CERMUSA Overview*. SFU Community Development Week, Loretto, PA.

Demuth, B. (Assistant Director for Telehealth) & Roberts, J. (Director). (2006, August 11). *Reaching Out To Persons With ALS (Lou Gehrig's Disease).* ArmTECH Showcase. Kittanning, PA: CERMUSA.

Wendekier, C. (Telehealth Development Specialist) & Pepon, B. (Diabetes Research Analyst). (2006, August 9-12). *Telehealth Interventions: Comparison of Private vs.Public Internet Participant Access.* American Association of Diabetes Educators Conference (AADE). Los Angeles, CA: CERMUSA.

Demuth, B. (Assistant Director for Telehealth), Knee, D. (Technology Coordinator), & Gaston, L. (Telehealth/IT Office Assistant (2006, July 28 -29). *CERMUSA Tours — John P. Murtha Rural Telehealth Research Center.* Saint Francis University Homecoming Weekend. Loretto, PA: CERMUSA.

Fuska, M. ((NTSS) Telehealth Technology Coordinator). (2006, July 10). Assistive Technology Demos for Saint Francis University Occupational Therapy Students. Johnstown, PA: NTSS/CERMUSA.

Pendleton, V. (Telehealth Development Specialist), Demuth, B. (Assistant Director for Telehealth), Litizinger, G. (Telehealth Developmental Specialist), Bender T. (Communications Platform Technology Manager), & Knee, D. (Technology Coordinator. (2006, June 26-27). *Remote Medical Evaluations using the Mobile Communications Platform (MCP).* 14th Annual Pennsylvania Rural Health Conference. State College, PA: CERMUSA.

Pendleton, V. (Telehealth Development Specialist). (2006, June 30). *Nursing and Telemedicine*. Presentation to Retired Johnstown Nurses. Johnstown, PA: CERMUSA.

Demuth, B. (Assistant Director for Telehealth), Roberts, J. (Director), Tonkin, K. (Assistant Director for Information Technology), & Griffin, R. (Assistant Director for Distance Learning. (2006, June 1-2). *Reaching Out To Persons With ALS (Lou Gehrig's Disease.* Showcase for Commerce. Johnstown, PA: CERMUSA.

Griffin, R. (Assistant Director for Distance Learning), Roberts, J. (Director), Demuth, B. (Assistant Director for Telehealth), & Tonkin, K. (Assistant Director for Information Technology). (2006, June 1-2). *Specialized Medical Training For Rural Medicine.* Showcase for Commerce. Johnstown, PA: CERMUSA.

Tonkin, K. (Assistant Director for Information Technology), Roberts, J. (Director), Demuth, B. (Assistant Director for Telehealth), & Griffin, R. (Assistant Director for Distance Learning). (2006, June 1-2). *Improving Tactical Intelligence With Technology.* Showcase for Commerce. Johnstown, PA: CERMUSA.

Mainhart, R. (Program Manager/MCP & REMED-D), & Litzinger, G. (Telehealth Development Specialist). (2006, May 25). *CERMSUA Telehealth Experiences & MCP and REMeD-D Overview*. Internet2 Presentation to MAGPI Virtual Forum: Healthcare and Medicine: CERMUSA.

Novak, S. (Telehealth Development Specialist). (2006, May 9). *Medical Evaluations of Neonates in Rural Areas*. American Telemedicine Association (ATA): Eleventh Annual International Meeting and Exposition. San Diego, CA: CERMUSA.

Pendleton, V. (Telehealth Development Specialist). Wolfe, D. (Wireless Communications Specialist), Roberts, J. (Director), Demuth, B. (Assistant Director for Telehealth), & Tonkin, K. (Assistant Director for Information Technology). (2006, May 8). *First Responder Emergency Communications-Mobile (FREC-M).* American Telemedicine Association (ATA): Eleventh Annual International Meeting and Exposition. San Diego, CA: CERMUSA.

Gerraughty, J. (Electronic Classroom/Video Production Manager). (2006, May 5). *Distance Learning: Lessons Learned.* Distance Learning demonstration to group from Upward Bound. Loretto, PA: CERMUSA.

Shanafelt, M. (Senior Information Technology Advisor), Wolfe, D. (Wireless Communications Specialist), & Owens, T. M.D. (Consultant). (2006, April 25). *Connected Home of the Future.* I2 Demonstration to the Library of Congress. Washington, DC: CERMUSA.

Shanafelt, M. (Senior Information Technology Advisor) & Dillion, R. (Information Technology Systems Administrator). (2006, April 24). *CERMUSA Overview.* I2 Demonstration to the Library of Congress. Washington, DC: CERMUSA.

Demuth, B. (Assistant Director for Telehealth). (2006, April 20). *Assistive Technologies.* Presentation to SFU President's Cabinet. Loretto, PA: CERMUSA.

Pendleton, V. (Telehealth Development Specialist). (2006, March 16). *Telemedicine and Nursing*. CERMUSA tour and telehealth presentation to Mount Aloysius student nurses, *John P. Murtha Rural Telehealth Research Center.* Saint Francis University Loretto, PA: CERMUSA.

Tonkin, K. (Assistant Director for Information Technology), Gerraughty, J. (Electronic Classroom/Video Production Manager), Reigh, M. (Production Assistant). (2006, April 3). *The Didjeridu: Exploring the Dreamtime with Jim Gagnon.* Interactive Videoconference via Internet2. Loretto, PA: CERMUSA.

Pendleton, V. (Telehealth Development Specialist). (2006, March 16). *Telemedicine and Nursing*. CERMUSA Telehealth presentation to University of Pittsburgh at Johnstown's Campus RN to BSN students. Johnstown, PA: CERMUSA.

Griffin, R. (Assistant Director for Distance Learning). (2006, March 15). *Connecting Technology Virtual Classroom Software.* PA/DE/NJ Distance Learning Association March Meeting. Villanova University, Villanova, PA: CERMUSA.

Novak, S. (Telehealth Developmental Specialist) & Fuska, M. ((NTSS) Telehealth Technology Coordinator). (2006, March 14). *Technology and Occupational Therapy.* Demonstration to Occupational Therapy Students at Saint Francis University. Loretto, PA: CERMUSA.

Tonkin, K. (Assistant Director for Information Technology), Shanafelt, M. (Senior Information Technology Advisor), & Griffin, R. (Assistant Director for Distance Learning). (2006, February 24). *Distance Learning: Lessons Learned.* BRAIN Network Internet2 Information Session. Saint Francis University, Loretto, PA: CERMUSA.

Demuth, B. (Assistant Director for Telehealth). (2006, February 24). Facilitator of Evaluation Working Subcommittee for 2006 Pennsylvania Diabetes Stakeholders "Kick Off" Meeting. Harrisburg, PA: CERMUSA.

Shanafelt, M. (Senior Information Technology Advisor). (2006, February 20). Freedom Calls. NTSS Center, Johnstown, PA: CERMUSA.

Shanafelt, M. (Senior Information Technology Advisor) & Gerraughty, J. (Electronic Classroom/Video Production Manager). (2006, January 19). *CERMUSA Overview & Successful Behaviors.* Challenge Program Presentation to High School Students. Flinton, PA: Glendale High School.

Griffin, R. (Assistant Director of Distance Learning). (2006, January 19). *Using Technology with Healthcare Using I2.* Videoteleconference Presentation for University of Scranton I2 Event. Loretto, PA: CERMUSA.

Wendekier, C. (Telehealth Development Specialist). (2006, January 12). *Health Related Quality of Life Perceptions In Relation to Glycemic Levels.* Presentation for Lunch and Learn Series for Hospital Employees. Uniontown, PA: Uniontown Hospital.

Rural Health Poster Presentations (7)

"CERMUSA Overview & NTSS Assistive Technology Expo" Eric Muncert & Mary Fuska, PA Training & Technical Assistance Network (PATTAN) Conference, Altoona, PA, November 2, 2006

"CERMUSA Diabetes Outreach" Camille Wendekier & Bonnie Pepon, Conemaugh Diabetes Institute's Diabetes Fair, Johnstown, PA, September 9, 2006.

"Cardiology At A Distance," Vicki Pendleton, American Telemedicine Association (ATA): Eleventh Annual International Meeting and Exposition, San Diego, CA, May 2006.

"Delivering Continuing Education to First Responders in Rural Areas," Gabrielle Cronin, American Telemedicine Association (ATA): Eleventh Annual International Meeting And Exposition, San Diego, CA, May 2006.

"Diabetic Foot Telehealth Screening," Eric Muncert, American Telemedicine Association (ATA): Eleventh Annual International Meeting and Exposition, San Diego, CA, May 2006.

"Telehealth Interventions in Relation to Quality of Life Outcomes," Camille Wendekier, American Telemedicine Association (ATA): Eleventh Annual Internationals Meeting and Exposition, San Diego, CA, May 2006. *(NOTE: ATA Blue Ribbon Winner)*

"Utilizing Technology to Promote Quality Assurance and Quality Improvement Activities in Rehabilitation Facilities," Eric Muncert, American Telemedicine Association (ATA): Eleventh Annual International Meeting and Exposition. San Diego, CA, May 2006.
"Cognitive Achievement Differences Comparing Linear Versus Modular Delivery," Gabrielle Cronin, New England Regional Conference of the Society of Academic Emergency Medicine, Shrewsbury, MA, March 2006.

Developing the Virtual Classroom

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Developing the Virtual Classroom for Distance Education Training

Protocol No.: **05-TATDL201-05**

Date: February 2, 2007

Protocol Title: Developing the Virtual Classroom for Distance Education Trial

Principal Investigator: Dana Friedman

Abstract:
CERMUSA previously conducted a protocol study to compare Virtual Classroom Software Packages (VCSP) in order to determine which VCSP would best meet the needs of a distance educational environment. From that comparison, the top three VCSP products were purchased to allow further evaluation.

CERMUSA has teamed with Saint Francis University and will continue to further examine these products, by using them in a real world education environment. By having a class taught completely at a distance CERMUSA hopes to discover if these tools are an acceptable alternative to the traditional residential classroom.

Introduction/Background:
Several years ago, CERMUSA purchased an online learning software package called iLinc. The product was demonstrated to a focus group made up of Saint Francis Unviersity, CERMUSA, and NMETC (Naval Medical Education Training Center) staff members. Visual Informational Directorate (VID), a department at NMETC, attended the demo and was very interested in the product. VID has the responsibility in NMETC of delivering video teleconferences to various hospitals and medical clinics within Navy medicine. VID realized that this product had the potential to save them money by eliminating costly ISDN and bridging fees. However, none of the protocol team was convinced that iLinc was the best product available.

Following this early look at iLinc, many additional tools were introduced to the marketplace. These tools became know as Virtual Classroom Software Packages (VCSP). A great deal of research began to appear discussing the value of VCSP. These citations note the value of the VCSP software as a group (Dutton 2004) (Graham et. Al. 2000) (Macromedia 2005) Macromedia 2005). The Saint Francis/CERMUSA focus group was tasked to research and evaluate as many off-the-shelf products that would fit into the timeframe allotted. After approximately 15 different vendor demonstrations of various collaborative learning software, five were selected. CERMUSA presented these top five to the NMETC VID department for further evaluation. From this, only three software packages were chosen.

Hypothesis:
VCSP offer an alternative to traditional classrooms while still being conducive to learning. Virtual calibration cannot only be an acceptable alternative to residential classroom learning, but can also help improve learning in rural areas by eliminating the need to travel long distances in order to attend residential classes.

Methods and Materials:
The various pedagogical theories of effective education in rural and medically under-served areas will be defined in the experimentation. The experiment design will implement and test three VCSP platforms of educational delivery to evaluate the technological modalities. The educational content will remain the same throughout the experiment, but the VCSP will differ. The cognitive and affective assessment practice, course evaluation, expert opinion, and

technology evaluation will determine the most appropriate technology delivery platform. The experiment will also develop a future research hypothesis with new technologies in distance education.

CERMUSA used three VCSP over the course of one semester with the course MBA 513 e-Business Management. These three uses were broken into 5-week evaluation sessions for a total of a 15 week period. In this protocol, VCSP Tool 1 was used to conduct the first five weeks of the course, VCSP Tool 2 was used to conduct the second five weeks of the course and VCSP Tool 3 was used to conduct the final five weeks of the course. Cognitive and affective results from each of the tools were analyzed in order to evaluate the VCSP tools. This protocol took take place from August 2006 to December 2006.

Key Research Accomplishments:

- Virtual classroom software is an acceptable alternative to live classroom
- The subjects that participated in the study showed a gain of knowledge
- The software was ranked
    1. iLinc
    2. Horizon
    3. MS Live Meeting

Reportable Outcomes/Research Results:
The paper that was written for EDUCAUSE has all this information. It is attached.

Conclusions/Discussions/Lessons Learned:
The results of this study support the hypothesis of this protocol. The rank of the software also supports the results from previous studies. The continuation of the protocol with the next version of the software and more subjects enrolled will improve and strengthen the findings.

References:

Dutton, John A. "Collaboration Tool Comparison." Spring 2004:

Graham, C., Cagiltay K., Craner J., and Lim, B. (2000). Teaching in a web based distance learning environment. *Center for Research on learning And technology*, 13-00, 1-21.

Macromedia Education, (n.d.). Case study University of Nevada, Las Vegas. Retrieved Mar. 31, 2005, from Macromedia - Showcase: Macromedia Case Study: University of Nevada, Las Vegas - Teaching Web site: http://www.macromedia.com/cfusion/showcase/index.cfm?event=casestudydetail&casestudyid=54001&loc=en_us.

Macromedia Education , (n.d.). Case study department of educational technology, san diego state. Retrieved Mar. 31, 2005, from Macromedia - Showcase: Macromedia Case Study: Department of Educational Technology, San Diego Web site: http://www.macromedia.com/cfusion/showcase/index.cfm?event=casestudydetail&casestudyid=45193&loc=en_us.

Extensions/Stretch Goals:
Next year, this protocol will be continued and research repeated. There are new advancements to the technology that will affect the data. This will also give us the opportunity to have more subjects in the study.

This study is important to distance education because the software that is being used is the missing ingredient in distance education. The software offers all the benefits of a live class without the inconvenience of traveling to the classroom. This could have benefits for military personnel that are deployed, allowing them to continue training. It also may be used for just-in-time training to personnel already deployed.

Appendices:
EDUCAUSE paper attached.

Discover How Virtual Classroom Software (VCS) Can Revolutionize Your Distance Education Classroom

Robert E. Griffin Dana M. Friedman John S. Miko

Abstract

Beginning in 2004 CERMUSA started a multiple year study to assess available virtual classroom software (VCS). By making a comprehensive review of VCS technology CERMUSA hoped to select the best tool for its own distance learning program as well as develop a framework that could be used to evaluate future entries into the VCS marketplace. This study was able to provide a ranking of currently available VCS tools, but also determined that further development is necessary in the field.

The Distance Education *Problem*

When teachers talk about distance education they usually think about teaching techniques that are inadequate replacements for the classroom experience. Teachers and students think about the *talking head* of the video teleconference; or of using the typed chat tools of Blackboard, WebCT, or some other type of course management system. This type of distance education has been available to the Academy for some time, but if this is your view of distance education, prepare for a revolution.

The emergence of web based collaboration tools, referred to in this paper as *virtual classroom software* or ***VCS tools***, provides the distance educator with new freedoms that allow a closer approximation of the residential classroom. For the first time the distance educator can carry on a voice conversation with his/her students without incurring the cost of long distance calling and costly phone bridges. It is as though the last tool for distance education has finally been discovered!

Since 2002 the Center of Excellence for Remote and Medically Under-Served Areas at Saint Francis University has been testing Virtual Classroom Software with the goal of finding the best tool for its distance education programs.

Background for the Project (Phases 1, 2, and 3)

In 2000, prior to the start of this study, CERMUSA completed a cursory investigation of all of the virtual classroom software that was available at that time. In this investigation we examined measures of audio, video, price, collaboration tools and how the software of that day managed those tools. At that time we purchased iLinc which met the early needs of our organization.

In 2004, after several years of using iLinc to support various projects, CERMUSA developed a project to find which VCS product was the best for delivering synchronous distance education. CERMUSA developed a protocol that consisted of three phases.

- Phase 1

  (September 2004 to May 2005) Phase 1 consisted of a focus group made up of Saint Francis University and CERMUSA employees. The focus group evaluated 13 different VCS tools. The demonstration of each package was presented by a sales representative of the respective software companies. After the demonstration each participant in the focus group was asked to complete a survey to determine what they liked or disliked about the presented VCS tool. Seven VCS tools were discarded as not worthy of further investigation at that time.
- Phase 2

(June 2005 to October 2005) In Phase 2 of the protocol, CERMUSA took the top 8 VCS tools that were determined to be the best during Phase 1 of the study to a group of Navy educators at the Naval Medical Center in Bethesda, MD. This group agreed to be part of the test because the Navy was actively investigating finding an alternative to their heavy use of videoconference tools for Navy medical education. The Navy educators went through the same process as the focus group did in phase 1 of the study.

Of the software that was taken to the Navy, two VCS tools were not able to be to be tested due to firewall / technical issues at Bethesda. One of the reasons the Navy test site was chosen was the rigorous nature of the military cyber security at that site.

Of the six VCS tools that were evaluated, the Navy found iLinc, MSLive Meeting, and HorizonWimba to be the superior tools.

- Phase 3

  (August 2006 to current) Phase 3 of the project tested the top three VCS tools derived from Phase 2 in a college classroom environment. The experimental challenge was to develop a course that had three equal parts. None of the course segments could be more complex than any other portion of the course.

  The three products that were ultimately investigated in Phase 3 of this study can all be classified as top-of-the-line VCS tools. Each is a quality product and has its own strengths and weaknesses. The products used in Phase 3 of the study are listed below.

    - iLinc (http://www.ilinc.com/home.php)
    - Microsoft® Live Meeting (http://www.microsoft.com/uc/livemeeting/default.mspx)
    - Horizon Wimba (http://www.horizonwimba.com)

  In the protocol, each section of the course was taught using a different VCS tool. Based on a random assignment, iLinc was chosen for use in module 1, Horizon Wimba was chosen for module 2, and Microsoft Live Meeting was chosen to deliver module 3.

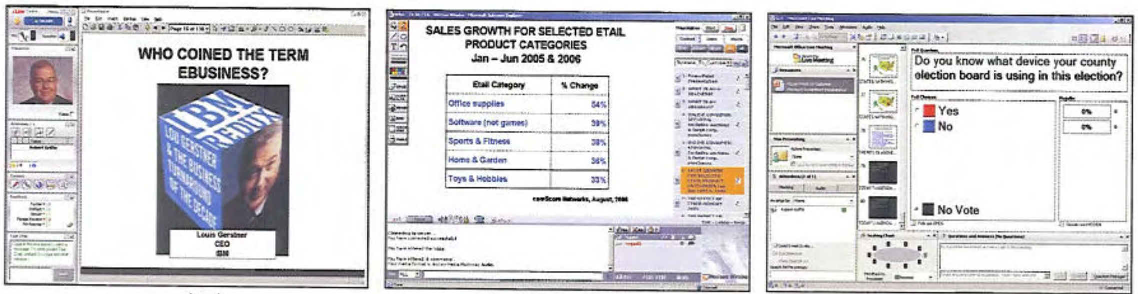
  The students enrolled in the course not only evaluated the software but also took pre and post test content tests to determine if they learned during the course.

What Is A VCS

A VCS tool is a server based software tool accessed from a computer that is connected to the internet. A VCS tool allows a teacher and a student (or students) to conduct almost any synchronous and asynchronous classroom activity online. Most VCS

tools allow the teacher and student to talk together, work as a team on a whiteboard and do other collaborative activities. These features will be discussed later in this paper. Screens from the VCS tools reported on in this paper are shown in Figure 1.

Figure 1
VCS Screens



iLinc
Version 8.0

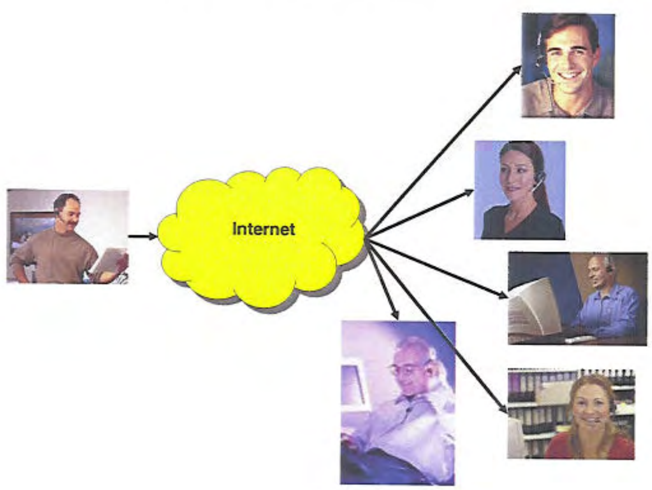
Horizon Wimba
Version 4.2.6

Microsoft Live Meeting
Version 7.6

How Is A VCS used?

A VCS should be easy to use. As the team discovered in their research, there are some excellent products available but many educators believe these tools are too difficult to use because of their complexity. A diagram of how a VCS tool connects the faculty to the student is shown in Figure 2.

Figure 2
How A VCS Works



VCS requires all users to connect to the Internet. In this example the teacher, on the left, connects to the VCS server located in the Internet cloud. The students are sent an invitation to attend and then connect to the same server using some type of internet connectivity. CERMUSA experiments were conducted using dial-up, DSL and cable modem connectivity and high speed network connectivity. Some VCS servers are owned

by the VCS user while other servers are hosted by VCS developers and are leased by the users. Students in a VCS classroom typically wear a headphone equipped with a microphone, which allows them hands free communication. Although less desirable, some students use the computer's built-in speaker and microphone.

Common Components of VCS Products

When this project first began in 2004, it was difficult to determine what separated VCS tools from other types of computer based communication software. For example, was Vonage[1] a VCS tool? As the project developed it became evident that VCS tools possessed certain attributes. A good VCS will have the following features:

Administrative features

- Download necessary

  Most VCS tools require each user to download a small program that allows their computer to communicate with the VCS host server. Because many students that will be using this software are sitting behind firewall protection and / or are restricted in their ability to download materials from the internet, this step can cause some difficulty for students. If the first class that the students will be attending uses the VCS software and the students are not aware of download issues with their computer, then everyone has difficulties. How the instructor manages these download issues can determine the success or failure of the event.
- Participant list

  A participant list tells the instructor who is attending the event. It usually lists the students first and last name so that the instructor can use this information to call on the student.
- Recording capability for delayed viewing

  This feature allows the instructor to activate the record function of the software so that a copy of the presentation can be made for later use by students. How this copy is displayed varies between VCS tools.
- Easy to use without extensive training

  While ease of use is a relative feature, it is important that people can use the tool without extensive training. While instructors may receive some training on using the VCS, students will likely have to use the tools with little to no training. In most cases training will be done during the student's early use of the VCS.

Display features

- Ability to display visuals

  Since PowerPoint is the defacto standard for most presentation slides, any VCS tool should be able to use PowerPoint. No VCS tool tested uses PowerPoint in its native form, only in a converted form. Since Power Point slides are converted, they should be shown in as close to their original state as possible. Additionally, since animations and slide transitions are important to some instructors, these features should also be preserved if possible.

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[1] Additional information about the communications provider Vonage can be found at http://vonage.com

- Preview of visuals

  Often an instructor proceeds through prepared visuals in a linear manner. In order to anticipate the next visuals in a discussion it is often helpful to be able to see the next slides and be able to anticipate the discussion points. There are a variety of methods VCS tools use to allow the user to look ahead. Some VCS tools provide only the slide number, some provide the slide title, and others provide a thumbnail view of the visuals. While it is possible to print paper copies of the visuals (PowerPoint slides) it is preferred that screen images of the slides be available.
- Whiteboard with annotation tools

  An electronic whiteboard, the modern alternative to the chalkboard, is a device that can be used by the instructor and also shared for individual students to use. The whiteboard should provide a variety of annotation tools and allow users to select between the tools. The user should be able to change the color of lines and text. Several of the annotation tool choices include: a typing tool to type words and symbols on the screen, pencil for freehand work, an ellipse and square for setting items apart for highlight, a highlight pen, pointer arrow, and other assorted devices. It is also important that the user has the ability to erase all or some of the markings made on the whiteboard. The whiteboard can be used in conjunction with a PowerPoint slide to highlight elements of a slide.
- Shared web browser

  Since the use of the internet is imperative today, it is convenient to have the ability to spawn a web site that can be shared with all participants. This feature allows the instructor to select a web site and to have it displayed on all participants computers.
- Application sharing capability

  Similar to the shared web browser, application sharing allows an instructor to share a software program with a participant. For example, if an instructor wants participants to view calculations in a spreadsheet, the instructor can have the original file shown on his computer and have an exact copy of the program running temporarily on the participant's computer without the participants having the software.

Communication features

- Audio

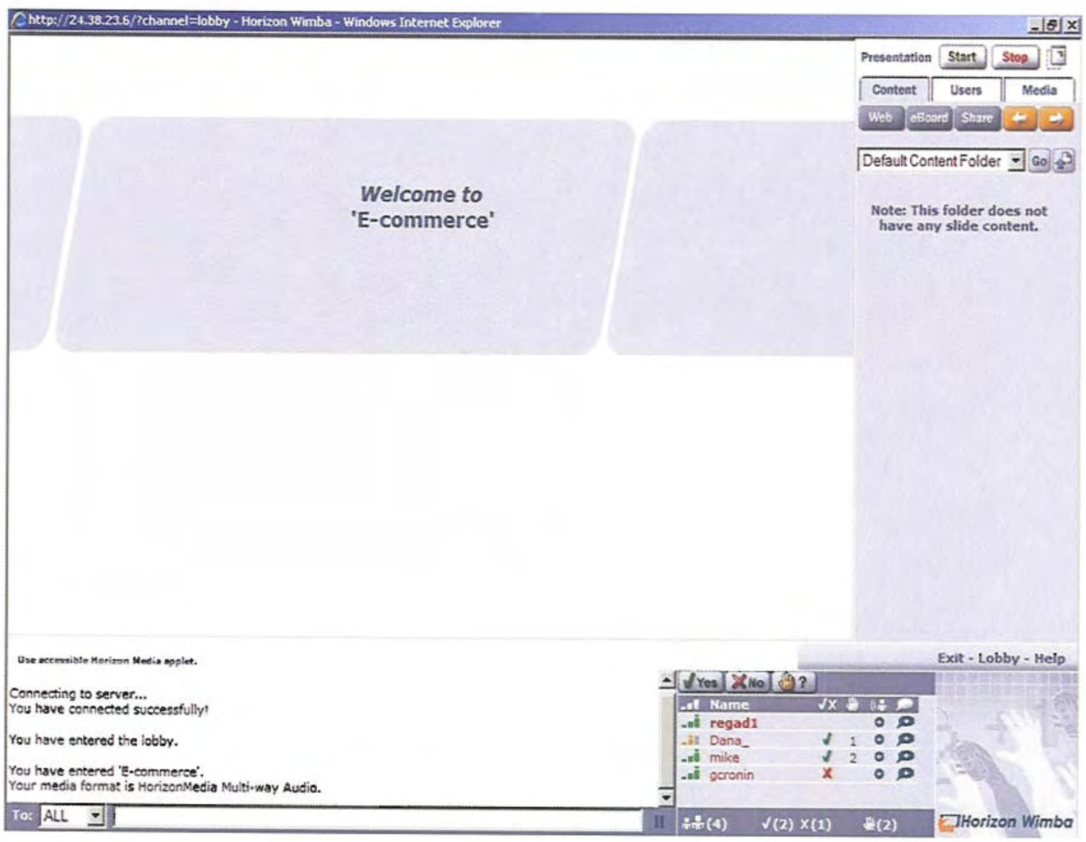
  One characteristic of all VCS tools is allowing synchronous audio broadcasting of the instructor's discussion. VCS tools use multiple methods for delivering this function. Some VCS tools use a conventional telephone call to provide the audio channel. If a telephone call is the technique used to deliver audio, remember that you will have the additional expense of a call and possibly the use of a telephone bridge. Other VCS tools use IP audio (Internet Protocol audio) to deliver sound. Some VCS tools allow you to use both telephone and IP audio. Additionally, all VCS tools provide one way audio that allow the instructor to talk to the participants. Some VCS tools allow two way audio.

- Text chat

  With sophisticated audio communication many users question the need for text chat. Why type when you can talk is the reasoning. There are two reasons for text chat. First, text chat can be used as a means for solving technical problems if you are not able to establish audio communication immediately. Technical assistance can text chat (IM) to participants to be sure they have their computer set up properly. The second use for text chat can be to log a question for the instructor. The participant may feel uncomfortable injecting an audio based question into the discussion and would rather post a written question for the presenter. Text chat is useful for that purpose. One important feature for text chat is the ability for the instructor to restrict access to the tool or have it turned off completely. Often text chat can become a distraction to the instructor.
- Interaction / Polling tools

  Often the interaction and polling tools are two separate tools. Primary Interaction / polling tools are the simpler of the two. An example of a primary interaction tool is shown in Figure 3 below.

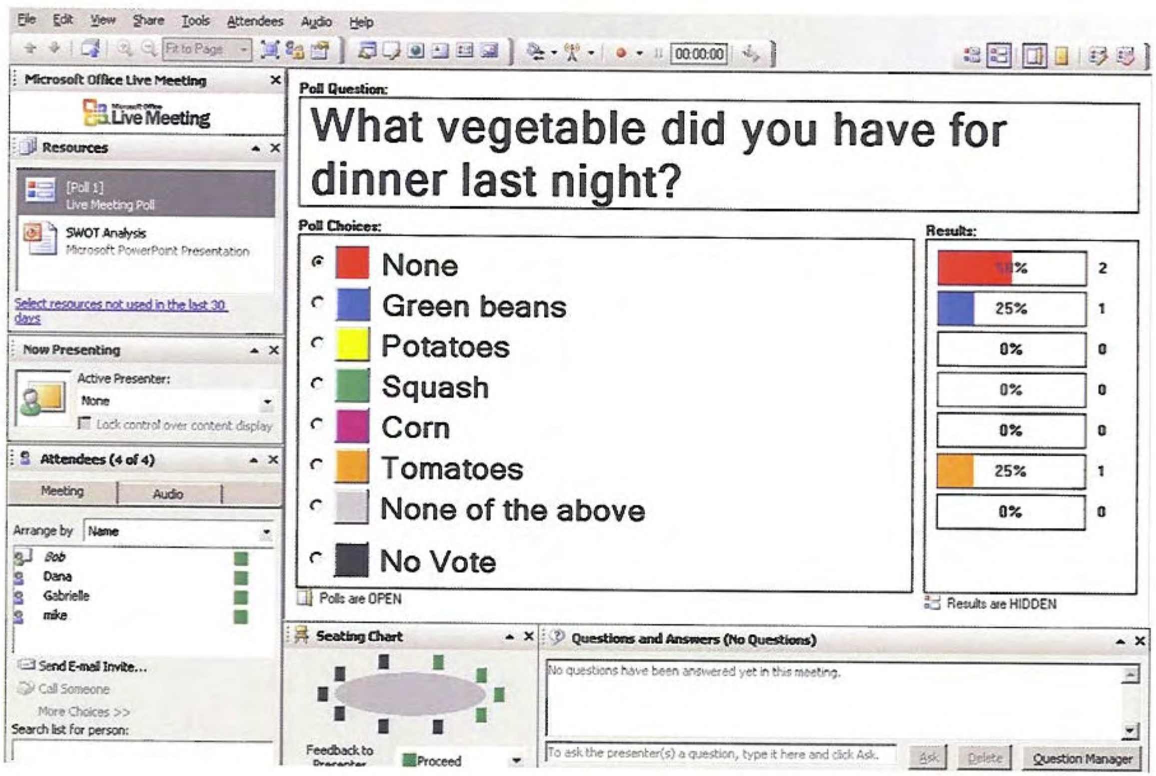
Figure 3
Primary Interaction / Polling Tool



Primary interaction tools are usually easy to locate in a VCS tool. With primary interaction tools a teacher may need to ask a simple yes / no question or question the participants on the pace of the instruction. This requires a simple radio button or check in a box in order for the students to respond.

Secondary interaction tools are a bit more robust. Secondary interaction tools are usually used by the instructor. With proper advanced planning the instructor can ask sophisticated multiple answer questions and then display the responses to the participants. For example, an instructor can ask participants what kind of vegetables they had for supper using the slide shown in Figure 4.

Figure 4
Secondary Interaction / Polling Tool



Participants click the radio button to the left of the colored square to place their response. As participants respond, the bars at the right of the slide

display the total. The instructor can then choose to display the polls results to all participants.

- Video of participants
  One feature that is beginning to appear in VCS tools is web camera based video. This video, while not completely full motion, allows instructors and participants to see each other in real time. The necessity of this type of video has yet to be proven; however, preliminary evidence from this study suggests that users like the ability to have video.

Cost of product

The cost of VCS tools was not considered until the final steps of Phase 3 of the project. The subjects in the study were never told the cost of the products and were led to believe that the products were of equal cost.

Our reasons for not considering costs earlier in the study concerned economics. At the beginning of the study the team felt that the prices charged for the VCS products were changing rapidly as is the case with new technology. In the early stages of VCS development, many potential users seemed to be willing to pay any price to purchase VCS tools therefore early prices were inflated. The economics of VCS tools has only recently begun to become stable and it is believed that competition will result in lower prices for these products. Current prices for the tested VCS tools are shown in Figure 5 below.

Figure 5
Fees Charged For Tested VCS Tools

	iLinc	Horizon Wimba	Microsoft Live Meeting
Initial Fee	$42,900 (33 seats)	$15,000 (50 seats)	$30,000 (50 seats)
Equipment	$6,000 (server)	$4,000	$4,500 (Hosting & License fees)
Total	$48,900	$19,000	$34,500
Cost per seat	$1,482	$380	$690
Yearly Maintenance	$8,000	$15,000	$34,500
Break Even Analysis	7 years & beyond	0 to 7 years	Never

Additional Costs

Additional costs were incurred with the use of the Microsoft Live Meeting VCS, the cost of carrying the live audio on the telephone. Live Meeting is capable of conducting one way audio broadcasts (teacher to students) with a VoIP transmission. In order to conduct a class with two way audio (teacher to student with return to teacher) the users must initiate a phone call. The first Microsoft Live Meeting class in this study was conducted with one way audio. Since the second and third classes required an interactive discussion, CERMUSA was obligated to use a phone bridge to have students respond. The cost for this connection at Saint Francis University is approximately 38 cents per minute per student connected. The costs of the 2 classes that were conducted are shown in Figure 6.

Figure 6
Phone Charges

Date Of Use	Minutes (Range) *variation is a result of student questions at the end of class*	Charges (w/o taxes)	Taxes	Charge per minute per student (includes taxes)
November 9, 2006	86 to 91	$150.62	$8.01	-
November 16, 2006	58 to 64	104.38	$5.56	-
TOTAL		**$255.00**	**$13.57**	**.38**

Findings from the Research

The course and subsequently the evaluative research study were divided into three separate and distinct modules. Each module of the course was conducted using a different VCS tool. Three distinct measures were taken:

- Pretest / Posttest of Cognitive Knowledge,
- Pretest / Posttest of Knowledge (Self Perception),
- VCS Feature Comparison.

Pretest / Posttest of Cognitive Knowledge

To assess student learning of the subject matter, a pretest was administered to each student to establish a baseline of the student's particular knowledge on the module's subject matter. After the module was completed, a posttest was administered to assess student learning. This measurement was the change between the pretest and posttest scores. Figure 6 represents the average pretest, posttest, and difference scores for each of the three course modules. Although it is difficult to gauge the impact of the VCS tools in student learning due to several factors including intervening environmental factors, the small sample size (n=3), and the varying knowledge that the subjects possessed of the subject matter prior to the educational intervention, each case student's average posttest scores increased over the pretest scores. Also, in each case, the students achieved a

proficient posttest score on the subject matter after the educational intervention. These results are shown in Figure 7.

Figure 7
Pretest / Posttest of Cognitive Knowledge

	N	Mean Pretest % Score	Mean Posttest % Score	Mean Difference
Module 1 (iLinc)	3	63.33%	94.17%	30.83%
Module 2 (Horizon)	3	73.33%	98.33%	25%
Module 3 (Live Meeting)	3	60%	76.67%	16.67%

Pretest / Posttest of Knowledge (Self Perception)

To assess and measure student's self-perception of knowledge before and after the intervention in each of the three modules, students were given a survey after each module. The survey asked students to gauge his or her own perception of their knowledge of the module's subject matter before and after the educational intervention. In this survey, students were presented with the major topics of each module and were asked to rate their knowledge of the material on a 4 point Likert scale as follows:

0 - Nothing about the topic.
1 - Very little about the topic.
2 - Something about the topic.
3 - A great deal about the topic.

Figure 8 represents the average increase of knowledge level based on the Likert scale. Once again it should be noted that although it is difficult to gauge the impact of the VCS tool in student learning due to the factors previously mentioned, for each module the students reported an average increase of knowledge level change as a result of the intervention.

Figure 8
Pretest / Posttest of Self Perception

	N	Mean Knowledge Level Change	Standard Deviation
Module 1 (iLinc)	12	1.083	0.900
Module 2 (Horizon)	18	1.889	1.023
Module 3 (Live Meeting)	9	1.556	0.726

VCS Feature Comparison

In an effort to ascertain the usability of the various features and functions of each VCS tool, after each module, students were asked to complete a comprehensive survey instrument. Each response regarding the various aspects of the VCS tool's usability were recorded by students on a 5 point Likert scale with 5 indicating "best" usability and 1 indicating "worst" usability. A class average on each of these measures was calculated and is displayed in the Figure 9.

Figure 9
VCS Feature Comparison

	N	iLinc	Horizon Wimba	Live Meeting
Ease of Use	3	4.33	3.67	3.33
Audio	3	4.00	3.00	4.00
Video	3	4.00	n/a	n/a
Whiteboard	3	4.33	4.33	4.00
PowerPoint	3	5.00	4.33	4.00
Shared Web Browser	3	4.67	4.33	4.33
Team Collaboration	3	5.00	4.33	2.33
Document Sharing	3	4.33	3.67	3.67
Intuitive Interface	3	4.67	3.67	3.33
Recording	3	4.00	4.67	4.00
Average		4.43	4.00	3.67

Additionally, all students were asked to rank each VCS tool that they had used to date. After the second module, all students ranked iLinc first and Horizon Wimba second. After the third module, all students continued to rank iLinc first and Horizon Wimba second with Live Meeting third. This overall assessment reinforces the synthesized averages shown in Figure 8.

Explanation of the Statistics

The data gathered as part of this evaluative research offers some interesting findings. Although it is impossible to gauge the impact of the VCS tool on student learning, it can be noted that in each instance student's average scores increased on the subject matter posttests; as well, students perceived and reported an increase of their own knowledge for each module's material. The software usability survey also provides a wealth of qualitative information about the features and functionality of each VCS tool that was part of the study.

As for a comparison of the VCS tools, iLinc rated higher on average for features, with Horizon Wimba second, and Microsoft Live Meeting third. On average, students also registered the highest percentage increase between the pre and posttest while using iLinc, with Horizon Wimba second, and Live Meeting third. This is also exactly how

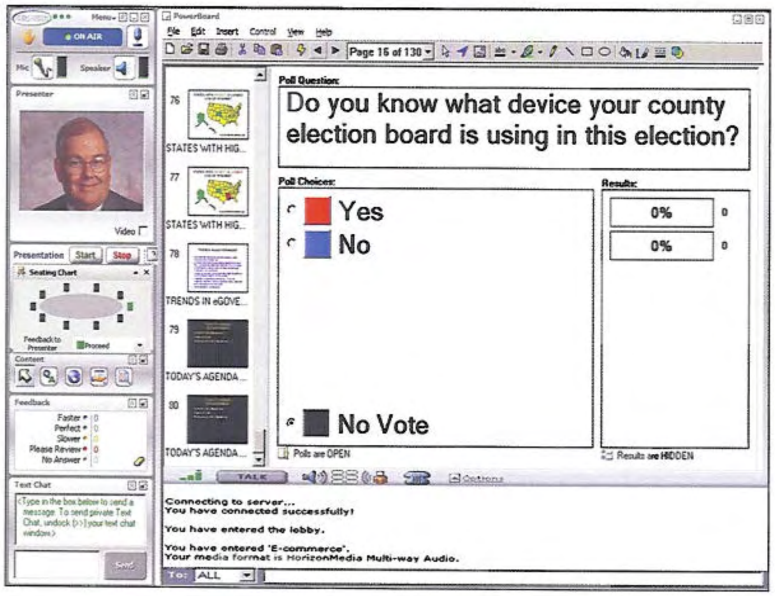
each software package was ranked overall by the participants when asked to rank order all three VCS tools.

The only comparison that does not follow this order is the comparison of self-reported assessment of learning where Horizon Wimba ranked first, Live Meeting second and iLinc third. However, this was most likely due to the fact that participants reported knowing a lot more initially about the material in the iLinc module (C2C) than the other two modules (B2B - B2C and G2B); therefore there was less of an opportunity for a gain.

Conclusions

The purpose of this study was to select the best off the shelf VCS tool to be used in CERMUSA distance learning projects. As the data indicates, however, none of these tools is perfect for all distance learning situations. Consequently, there are elements of each of the VCS tools that we believe we would include in the *perfect* VCS tool. Figure 10 shows a hypothetical example of this ideal VCS tool.

Figure 10
The *Perfect* Hypothetical VCS Tool



Here is what we would include:

From iLinc:

- Presenter picture or video picture that automatically follows who is speaking
- Hand raised symbol that changes color
- VU meters for microphone and speaker
- Feedback feature (pie graph)
- Whiteboard tools not on the pull down menu.
- Hand raise and call on for speaker control for audio
- Text chat (tied with Horizon Wimba)

From Horizon Wimba:

- Whiteboard erase tool
- Audio quality
- Ability to selectively control student use
- Moving pointer arrow
- Push to talk from all parties
- Telephone phone option
- Start recording control
- Text chat (tied with iLinc)

From Microsoft Live Meeting:

- PowerPoint thumbnails
- Ease of uploading PowerPoint files
- Ability to show slide animations and transitions
- Seating chart
- Addition of application sharing, polling questions and whiteboard slides in PowerPoint sequence
- Ease of posting and playback of recorded classes in a Learning Management System

What a wonderful virtual world it would be if we could combine the best of the best into a VCS tool. In fact this ideal situation will likely take place in the marketplace. There is a great deal of activity in the VCS marketplace that is causing companies to upgrade existing tools and remove features that are not going to keep pace. As an example, Microsoft Live Meeting is currently beta testing Live Meeting Version 8 which may include video and two way IP audio. Horizon Wimba has also announced the acquisition of new capital that will likely allow the company to add additional features to its VCS tool.[2] Because of the importance of this marketplace, companies are making rapid technological advances to insure success. We, the customers will ultimately benefit.

This project is supported by Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) in Loretto, Pennsylvania, and funded by the U.S. Army Medical Research and Materiel Command (USAMRMC) Telemedicine and Advanced Technology Research Center (TATRC), Fort Detrick, Maryland - Contract Number W81XWH-06-2-0018.

[2] Get online citation.

Appendix A
Features Matrix with featured VCS Tools

Features	iLinc	Horizon Wimba	Microsoft Live Meeting
Administrative features			
Download necessary	Download LL7Class7.exe	Run Set-up Wizard • Allow pop-ups • Java • Allow signed audio applet • QuickTime	Install Live Meeting console.exe
Participant list (names of students attending class)	√	√	√
Recording capability for delayed viewing	√	√	√
Ability to display recorded unit	Plays proprietary .lrc file using downloaded player	Plays proprietary file from server	Plays Windows Media file
Easy to use without extensive training	√	√	√
Display features			
Ability to display visuals (PowerPoint (PP) slides)	Converts PP to .jpg (image may be displayed in an altered format, no transitions or animations shown)	Converts PP to .jpg (image may be displayed in an altered format, no transitions or animations shown)	.lmp
Preview of visuals (PowerPoint slides)	Visual #'s only	Slide titles only	Thumbnails
Whiteboard with annotation tools	√ but lacks easy itemized erasure	√	√
Shared web browser	√	√	√
Application sharing capability	√	√	√
Communication features			
Audio (Phone or IP, one way audio or two way audio)	IP audio only	IP audio & phone audio	Phone or phone converted to IP audio
Text chat	√	√	Single person text chat with separate presenter questions
Primary interaction / polling tools	√	√	Available but not robust
Secondary interaction / polling tools	√	√	√
Video of presenter & participants	√		
Cost			

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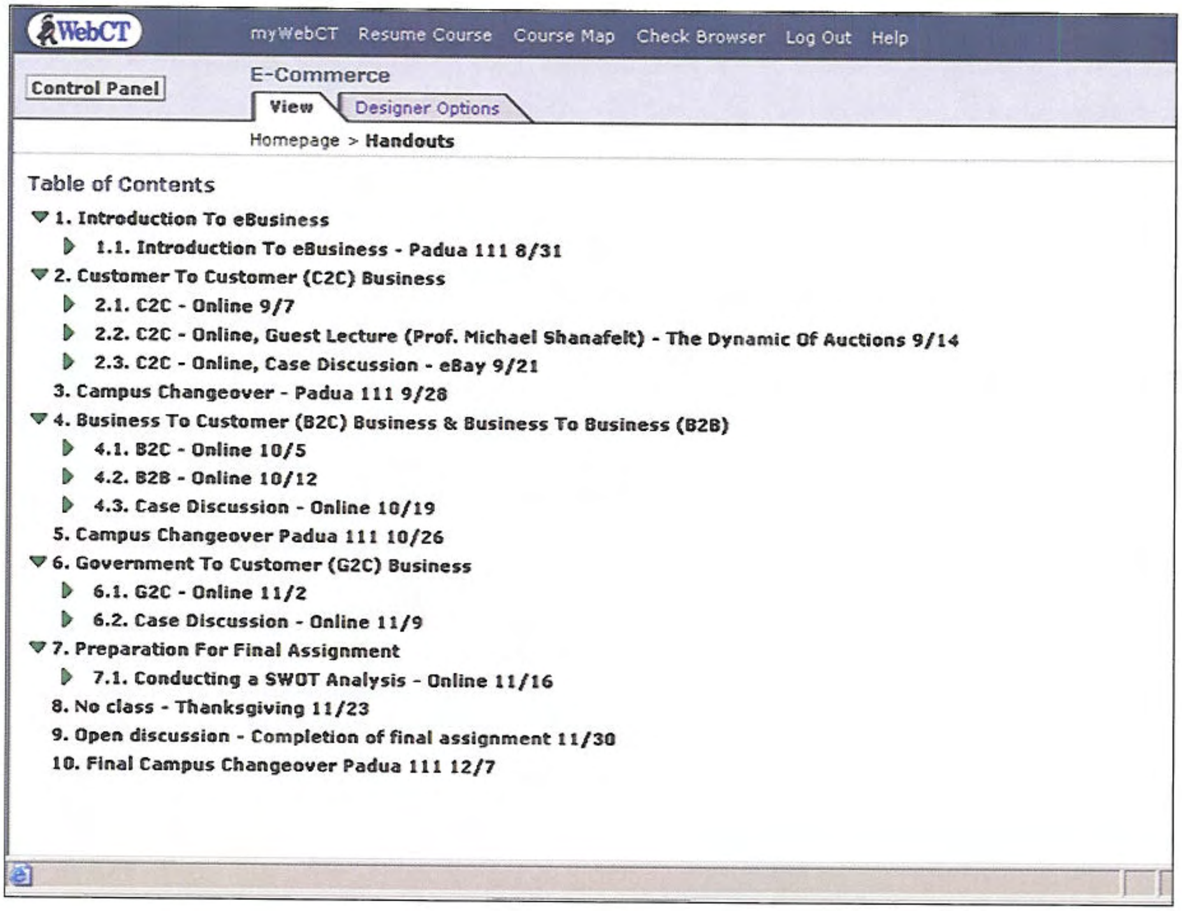
Appendix B
Course Outline



Order of VCS tools used for test were randomly assigned.
Module 1 – Section 2 – iLinc
Module 2 – Section 4 – Horizon Wimba
Module 3 – Section 6 – Microsoft Live Meeting

Done live on campus – Sections 1, 3, 5, 7, 9 and 10

Appendix C
Module 1 (iLinc) Self-Reported Assessment of Student Learning

Question 1 and 2
A topic covered in eBusiness 513 was C2C (Customer to Customer) business examples. In this topic we discussed eBay and Wikipedia as two examples of C2C businesses.

	Student 1		**Student 2**		**Student 3**	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)			**X**			
Very little about the topic (1)						
Something about the topic (2)	**X**				**X**	
A great deal about the topic (3)		**X**		**X**		**X**
Change	**+1**		**+3**		**+1**	
Average Change	**+1.67**					

Question 3 and 4
A topic covered in eBusiness 513 was file sharing businesses like Napster and their unique place in the marketplace.

	Student 1		**Student 2**		**Student 3**	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)	**X**					
Something about the topic (2)		**X**	**X**		**X**	
A great deal about the topic (3)				**X**		**X**
Change	**+1**		**+1**		**+1**	
Average Change	**+1**					

Question 5 and 6
A topic covered in eBusiness 513 was intranets (intranets as compared to internets). In this topic we discussed your own company intranets.

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)						
Something about the topic (2)					**X**	**X**
A great deal about the topic (3)	**X**	**X**	**X**	**X**		
Change	**0**		**0**		**0**	
Average Change	**0**					

Question 7 and 8
A topic covered in eBusiness 513 was a discussion of Google. You will recall that we discussed this topic as the Internets Internet.

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)			**X**		**X**	
Something about the topic (2)	**X**					
A great deal about the topic (3)		**X**		**X**		**X**
Change	**+1**		**+2**		**+2**	
Average Change	**+1.67**					

Appendix D
Module 2 (Horizon Wimba) Self-Reported Assessment of Student Learning

Question 1 and 2
A topic covered in eBusiness 513 was a term called etailing.

	Student 1		**Student 2**		**Student 3**	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)	X		X		X	
Very little about the topic (1)						
Something about the topic (2)						
A great deal about the topic (3)		X		X		X
Change	**+3**		**+3**		**+3**	
Average Change	**+3**					

Question 3 and 4
A topic covered in eBusiness 513 was *the vocabulary of the Internet. Terms such as splash page and homepage were discussed.*

	Student 1		**Student 2**		**Student 3**	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)	X					
Something about the topic (2)			X		X	
A great deal about the topic (3)		X		X		X
Change	**+2**		**+1**		**+1**	
Average Change	**+1.33**					

Question 5 and 6

A topic covered in eBusiness 513 was *a number of statistics detailing the scope of B2C business.*

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)	**X**					
Very little about the topic (1)			**X**			
Something about the topic (2)					**X**	
A great deal about the topic (3)		**X**		**X**		**X**
Change	**+3**		**+2**		**+1**	
Average Change	**+2**					

Question 7 and 8

A topic covered in eBusiness 513 was *a comparison between B2C (Business to Customer) and B2B (business to business).*

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)	**X**		**X**			
Something about the topic (2)						
A great deal about the topic (3)		**X**		**X**	**X**	**X**
Change	**+2**		**+2**		**0**	
Average Change	**+1.33**					

Question 9 and 10
A topic covered in eBusiness 513 was *the types of B2B business. Topics such as extranet and infomediary were discussed.*

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)	**X**					
Very little about the topic (1)			**X**			
Something about the topic (2)					**X**	
A great deal about the topic (3)		**X**		**X**		**X**
Change	**+3**		**+2**		**+1**	
Average Change	**+2.0**					

Question 11 and 12
A topic covered in eBusiness 513 was *some general facts and statistics about B2B.*

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)	**X**					
Very little about the topic (1)			**X**			
Something about the topic (2)						
A great deal about the topic (3)		**X**		**X**	**X**	**X**
Change	**+3**		**+2**		**0**	
Average Change	**+1.67**					

Appendix E
Module 3 (Live Meeting) Self-Reported Assessment of Student Learning

Question 1 and 2
A topic covered in eBusiness 513 was a description of G2C (Government to Customer) business and how it is really G2C, G2B, and G2G.

	Student 1		**Student 2**		**Student 3**	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)					**X**	
Something about the topic (2)	**X**		**X**			
A great deal about the topic (3)		**X**		**X**		**X**
Change	**+1**		**+1**		**+2**	
Average Change	**+1.33**					

Question 3 and 4
A topic covered in eBusiness 513 was the forms of G2C business. This topic discussed how G2C was also G2B and G2G.

	Student 1		**Student 2**		**Student 3**	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)						
Very little about the topic (1)			**X**		**X**	
Something about the topic (2)	**X**			**X**		
A great deal about the topic (3)		**X**				**X**
Change	**+1**		**+1**		**+2**	
Average Change	**+1.33**					

Question 5 and 6

A topic covered in eBusiness 513 was some general facts and statistics about G2C.

	Student 1		Student 2		Student 3	
Knowledge level	**Before**	**After**	**Before**	**After**	**Before**	**After**
Nothing about the topic (0)					**X**	
Very little about the topic (1)	**X**		**X**			
Something about the topic (2)				**X**		
A great deal about the topic (3)		**X**				**X**
Change	**+2**		**+1**		**+3**	
Average Change	**+2**					

Appendix F
Module 1(iLinc) Usability Software Survey

Question 1
What software are you evaluating?

	N	Percentage
a. iLinc	3	100%
b. Horizon Wimba	0	0%
c. Microsoft Live Meeting	0	0%
Total	3	100%

Question 2
How do you rate this software in terms of ease of use? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 3
How do you rate this software for audio? Rank from A as the Best to E as the Worst.

a. Best
b. B
c. C
d. D
e. Worst
f. Does not apply

	N	Percentage
a. **Best**	1	33.33%
b. B	1	33.33%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 4
How do you rate this software for video? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	0	0%
b. B	3	100%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 5
How do you rate this software for whiteboard? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 6
How do you rate this software for PowerPoint? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	3	100%
b. B	0	0%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 7
How do you rate this software for shared web browser? A shared web browser is where the instructor takes you into a web site of their choosing. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	0	0%
b. B	2	66.67%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 8
How do you rate this software for team / group collaboration? This is where students are able to work together without the faculty controlling the interaction. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	3	100%
b. B	0	0%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 9

How do you rate this software for document sharing? This is where the faculty shares a word or spreadsheet file created on his/her computer with you. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 10

How do you rate this software for having an intuitive interface? Did you find the software easy to manipulate and did you find the features easy to use? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	2	66.67%
b. B	1	33.33%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 11
The VCS software allows the instructor to record a class. Did you use any of the recordings to review a class?

	N	**Percentage**
a. I didn't use it	1	33.33%
b. 1	1	33.33%
c. 2	1	33.33%
d. 3	0	0%
e. 4	0	0%
f. 5	0	0%
g. More than 5	0	0%
Total	3	100.00%

Question 12
What feature or features was the most beneficial to your class? Why?

White board, chat room, and feedback section. Offered visual graphics to follow PowerPoint, see instructor highlight sections, and participate in class quickly through chat and feedback.

Video was probably the best benefit. It allowed us to interact more as a group.

The audio. I found it a very effective tool for an internet class. The video was nice also, but not necessary. I enjoyed using ilinc.

Question 13
What feature or features was the least beneficial to your class? Why?

Video Amount of time to switch between users wasn't as quick as the feedback and chat section. It did, however, show that the student was in the room for the class.

I honestly can't think of one.

I can say that all the features were beneficial to me in this class. But, if I am asked to name the least beneficial portion I would name the video component because it is not necessary for the class to function.

Question 14
How many classes (other than the class we held in the classroom) did you participate in from your office?

	N	Percentage
a. 0	1	33.33%
b. 1	1	33.33%
c. 2	1	33.33%
d. 3	0	0%
Total	3	100.00%

Question 15
How many classes (other than the class we held in the classroom) did you participate in from your home?

	N	Percentage
a. 0	0	0%
b. 1	1	33.33%
c. 2	0	0%
d. 3	2	66.67%
Total	3	100.00%

Question 16
How many classes (other than the class we held in the classroom) did you participate in from another location?

	N	Percentage
a. 0	3	100%
b. 1	0	0%
c. 2	0	0%
d. 3	0	0%
Total	3	100.00%

Question 17
If you answered another location to the previous question, please describe the location.

n/a

n/a

I only attended class from home.

Question 18
Do you have additional comments about the software?

I enjoyed participating in the class with this software.

No response

The only comments I would make is that the video could lag a little sometimes. The audio skipped a little when the Web browser component was opened.

Appendix G
Module 2(Horizon Wimba) Usability Software Survey

Question 1
What software are you evaluating?

	N	Percentage
a. iLinc	0	0%
b. Horizon Wimba	3	100%
c. Microsoft Live Meeting	0	0%
Total	3	100%

Question 2
How do you rate this software in terms of ease of use? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	0	0%
b. B	2	66.67%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
f. Does not apply	0	0%
Total	3	100.00%

Question 3
How do you rate this software for audio? Rank from A as the Best to E as the Worst.

a. Best
b. B
c. C
d. D
e. Worst
f. Does not apply

	N	Percentage
a. **Best**	0	0%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	1	33.33%
f. Does not apply	0	0%
Total	3	100.00%

Question 4
How do you rate this software for video? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	0	0%
b. B	0	0%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	3	100%
Total	3	100%

Question 5
How do you rate this software for whiteboard? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 6
How do you rate this software for PowerPoint? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 7
How do you rate this software for shared web browser? A shared web browser is where the instructor takes you into a web site of their choosing. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 8
How do you rate this software for team / group collaboration? This is where students are able to work together without the faculty controlling the interaction. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	2	66.67%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 9
How do you rate this software for document sharing? This is where the faculty shares a word or spreadsheet file created on his/her computer with you. Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	1	33.33%
b. B	0	0%
c. C	2	66.67%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 10
How do you rate this software for having an intuitive interface? Did you find the software easy to manipulate and did you find the features easy to use? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	0	0%
b. B	2	66.67%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 11
The VCS software allows the instructor to record a class. Did you use any of the recordings to review a class?

	N	Percentage
a. I didn't use it	1	33.33%
b. 1	1	33.33%
c. 2	1	33.33%
d. 3	0	0%
e. 4	0	0%
f. 5	0	0%
g. More than 5	0	0%
Total	3	100.00%

Question 12
What feature or features was the most beneficial to your class? Why?

> Horizon Wimba loaded up quickly on my laptop when I had to change class locations at the last minute.
>
> I thought Horizon Wimba felt more close and interactive than did ilinc, the first program that we tested for the course.
>
> The PowerPoint function was very nice and easy to follow. It really kept us on track with class.

Question 13
What feature or features was the least beneficial to your class? Why?

> I didn't like the fact you had to hold down the talk key to speak.
>
> I didn't like that fact that we had to hold the talk button down while talking. You could not use your hands very easily to look in your notebook or look in a print out for information that you wanted to refer to while making a comment.
>
> The audio was horrible. The sound kept going in and out.

Question 14
How many classes (other than the class we held in the classroom) did you participate in from your office?

	N	Percentage
a. 0	1	33.33%
b. 1	2	66.67%
c. 2	0	0%
d. 3	0	0%
Total	3	100.00%

Question 15
How many classes (other than the class we held in the classroom) did you participate in from your home?

	N	Percentage
a. 0	0	0%
b. 1	0	0%
c. 2	2	66.67%
d. 3	1	33.33%
Total	3	100.00%

Question 16
How many classes (other than the class we held in the classroom) did you participate in from another location?

	N	Percentage
a. 0	2	66.67%
b. 1	1	33.33%
c. 2	0	0%
d. 3	0	0%
Total	3	100.00%

Question 17
If you answered another location to the previous question, please describe the location.

My neighbor's house. My Verizon DSL account went down and I had to run to my neighbor's house to jump on his wireless and participate in class. I missed maybe 5 minutes that day.

I did not use any other location other than home.

n/a

Question 18
Do you have additional comments about the software?

Software was easy to use.

I really enjoyed almost everything about Horizon Wimba, except for the fact that you had to hold the talk button down while speaking.

The archived classes for Horizon Wimba were very beneficial. I missed a class due to a conference call at work and was able to watch the class at a later time.

Appendix H
Module 3 (Live Meeting) Usability Software Survey

Question 1
What software are you evaluating?

	N	Percentage
a. iLinc	0	0%
b. Horizon Wimba	0	0%
c. Microsoft Live Meeting	3	100%
Total	3	100%

Question 2
How do you rate this software in terms of ease of use? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	0	0%
c. C	1	33.33%
d. D	1	33.33%
e. **Worst**	0	0%
f. Does not apply	0	0%
Total	3	100.00%

Question 3
How do you rate this software for audio? Rank from A as the Best to E as the Worst.

a. Best
b. B
c. C
d. D
e. Worst
f. Does not apply

	N	Percentage
a. **Best**	1	33.33%
b. B	1	33.33%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
f. Does not apply	0	0%
Total	3	100.00%

Question 4
How do you rate this software for video? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	0	0%
b. B	0	0%
c. C	0	0%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	3	100%
Total	3	100%

Question 5
How do you rate this software for whiteboard? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	1	33.33%
b. B	1	33.33%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 6
How do you rate this software for PowerPoint? Rank from A as the Best to E as the Worst.

	N	**Percentage**
a. **Best**	1	33.33%
b. B	1	33.33%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 7

How do you rate this software for shared web browser? A shared web browser is where the instructor takes you into a web site of their choosing. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	2	66.67%
b. B	0	0%
c. C	1	33.33%
d. D	0	0%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 8

How do you rate this software for team / group collaboration? This is where students are able to work together without the faculty controlling the interaction. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	0	0%
b. B	1	33.33%
c. C	0	0%
d. D	1	33.33%
e. **Worst**	1	33.33%
F. Does not apply	0	0%
Total	3	100.00%

Question 9

How do you rate this software for document sharing? This is where the faculty shares a word or spreadsheet file created on his/her computer with you. Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	1	33.33%
c. C	0	0%
d. D	1	33.33%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 10

How do you rate this software for having an intuitive interface? Did you find the software easy to manipulate and did you find the features easy to use? Rank from A as the Best to E as the Worst.

	N	Percentage
a. **Best**	1	33.33%
b. B	0	0%
c. C	1	33.33%
d. D	1	33.33%
e. **Worst**	0	0%
F. Does not apply	0	0%
Total	3	100.00%

Question 11
The VCS software allows the instructor to record a class. Did you use any of the recordings to review a class?

	N	Percentage
a. I didn't use it	1	33.33%
b. 1	1	33.33%
c. 2	1	33.33%
d. 3	0	0%
e. 4	0	0%
f. 5	0	0%
g. More than 5	0	0%
Total	3	100.00%

Question 12
What feature or features was the most beneficial to your class? Why?

Recordings of the class. My DSL connection was lost during class and I was able to review the part I missed.

n/a

The feature that was most beneficial to the class was viewing the PowerPoint also being able to type answers onto the whiteboard.

Question 13
What feature or features was the least beneficial to your class? Why?

Missed the video. Definitely missed the ability to talk. Class was less interactive.

N/A

I think the fact that this program does not have a way to speak to each other through the program was not beneficial. When we were able to speak to each other by conference call it was awkward to hold a phone the whole time. I was hesitant to use the speaker phone on my phone because I thought it might be too loud. I enjoy using headphones more.

Question 14
How many classes (other than the class we held in the classroom) did you participate in from your office?

	N	Percentage
a. 0	3	100%
b. 1	0	0%
c. 2	0	0%
d. 3	0	0%
Total	3	100.00%

Question 15
How many classes (other than the class we held in the classroom) did you participate in from your home?

	N	Percentage
a. 0	0	0%
b. 1	0	0%
c. 2	0	0%
d. 3	3	100%
Total	3	100.00%

Question 16
How many classes (other than the class we held in the classroom) did you participate in from another location?

	N	Percentage
a. 0	3	100%
b. 1	0	0%
c. 2	0	0%
d. 3	0	0%
Total	3	100.00%

Question 17
If you answered another location to the previous question, please describe the location.

n/a

n/a

n/a

Question 18
Do you have additional comments about the software?

I like this software when I use it for troubleshooting software at my work location. The ability to share the desktop was great. I didn't like this software for this class.

n/a

I think that if this software included a way to speak to each other through the computer it would have been a better program to use. Although, we were still able to get everything done without it.

- Instructor's comments
- Student comments
- Technical comments
- Video examples website

Continuing D. Ed. for Rural Pharmacists

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Continuing Distance Education for Rural Pharmacists

Protocol No.: **05-TATDL202-05**

Date: February 2, 2007

Protocol Title: Continuing Distance Education for Rural Pharmacists

Principal Investigator: Kristine Anderson

Abstract:
In order to maintain their licensure, pharmacists and pharmacy technicians are required to participate in accredited continuing education. Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) has designed eight asynchronous-led pharmaceutical distance education courses. These courses will be tested with pharmacists and pharmacy technicians in rural and remote areas. The effective use of instructional approaches will be determined by examining several methods of delivery and pedagogic techniques of teaching at a distance.

All of the courses have been developed and approved in conjunction with the Accreditation Council of Pharmacy Education (ACPE) guidelines. These courses were developed with ACPE's key goals and objectives in mind to obtain a high-level of student learning outcomes and knowledge retention. Due to the delay in the start of data collection, this study has been extended for another year to accommodate student's input and be available at the time of year (late spring and summer) when students are the most available to participate in cognitive measurements for the study.

Introduction/Background:

Introduction to the Problem
Distance education and the concept of the virtual classroom is an area of considerable interest to educators and medical professionals (Nixon & Helms, 1997). Many pharmacists and pharmacy technicians lead double lives as a medical professional and as a family member. Qualitative focus group studies have reveled that many pharmacists and pharmacy technicians work full time and have a family and many other responsibilities at home. These factors, combined with the rural nature of places like Western Pennsylvania, create a long list of limitations for many pharmacists and pharmacy technicians in rural areas to easily obtain their accreditation to keep their pharmacy license active.

Distance learning does represent a strategic shift in the method education is delivered and answers the problems found in significant research studies. A study published in the Canadian Journal of Rural Medicine (2000) revealed many medical professionals were simply not aware of the availability of continuing medical education programming (Curran, et al., 2000). A large number of rural medical professionals reported that distance education and the availability of self-directed learning credit also had a high degree of impact on their access to continuing medical education programming (Curran, et al., 2000). Other factors that prevented rural pharmacists and pharmacy technicians from accessing continuing medical education included lack of time, lack of financial resources, perceived relevance of topic, and reputation of the provider (Curran, et al., 2000).

It is no coincidence that rural medical providers experience greater difficulty accessing, and participating in, continuing medical education. The very factors that characterize rural medicine also present significant barriers for participating in continuing medical education activities.

Geographic distance contributes to the cost of attending continuing medical education activities and increases the time away from family and practice. Arranging locum coverage for practice and hospital responsibilities is another difficulty. These obstacles are of great concern to rural pharmacists, who must maintain their skills (Curran, et al., 2000).

The practice of medicine is being updated and changed constantly as a result of new clinical findings or research. These changes have a direct impact on medical practitioners, who must be able to maintain their competencies in light of new developments and advances in medical knowledge (Curran, et al., 2000). Pharmacists and pharmacy technicians engage in a variety of informal and formal continuing medical education activities throughout their careers. Several meta review studies of the outcomes and impact of continuing medical education programs have suggested that well organized and planned learning activities, based on the collection of information regarding learning needs, can be effective in developing and enhancing the knowledge and skills of practitioners (Curran, et al., 2000).

This study sought to research these barriers mentioned above for pharmacists and pharmacy technicians in rural Pennsylvania to participate in continuing medical education programs. The solutions to these barriers will produce proficient online learning courses that will ultimately be an effective learning experience for the participants (Taylor, 2002).

Background

This study seeks to conduct research in developing continuing education opportunities for licensed pharmacists and pharmacy technicians. These courses will be illustrations of asynchronous education at-a-distance (Chen, 2004; Gay & Airasian, 2002). The learner-centered focus of the curricula will promote learners of every style, (being auditory, visual, or kinetic), to place emphasis in the active learning environment with their own style of learning (Ornstein & Hunkins, 1998). Research has shown that the art of engaging students results in better performance and higher retention of the materials (Norris, 1998; Chen, 2004).

This study assessed the needs of pharmacists, developed courses to meet the needs of the audience, built course content, and will implement and evaluate courses through a series of beta-testers and subject volunteers. The courses were developed in conjunction with the ACPE guidelines (NABP Survey of Pharmacy Law, 1998); these stand alone credit-based courses are designed to provide pharmacists and pharmacy technicians with continuing education, as examples of non-instructor led education (Ornstein and Hunkins, 1998). The continuing education opportunities that the study has developed are:

- Treatment of Anemia
- Therapeutic Uses of Natural Products
- Treatment of Non-Emergent Congestive Heart Failure & Associated Peripheral Edema
- Treatment of the Asthmatic Patient
- Native American Medicines
- Diabetes Mellitus in Amputation Considerations
- Anxiety Medications and Returning War Wounded
- Pharmaceutical Treatments with Post-Traumatic Stress Disorder

These courses will be released to military and public pharmacy professionals to collect data and maintain research to develop an online seminar series on new medications. The data collection will answer technical objectives imposed on the study. Revisions will be performed to the courses under care of a licensed medical physician as deemed necessary in the research.

Purpose and Rationale of the Study
The purpose of this study is to measure the effectiveness of multiple learning techniques utilized in distributed education to deliver continuing education courses, conducted over a one-year period to licensed pharmacists and pharmacy technicians in rural and under-served areas. For pharmacists and pharmacy technicians in areas like these, it is difficult to receive traditional educational opportunities. Participants in the experiment will receive course contents over the Internet, using features such as Internet-based case studies, examinations, active learning activities, and cognitive questionnaires.

All of the subjects will be currently licensed pharmacists and pharmacy technicians seeking clinically-based continuing education units to maintain their state licensure. These subjects who complete the course requirements received ACPE approved continuing education credits. The subjects in the study will be competent to provide informed consent and under no physical risk in any course of study.

The study has obtained the title of an accredited ACPE provider of continuing medical education for pharmacists and pharmacy technicians by completing a rigorous application procedure. ACPE's new regulations require a new element for continuing education; the inclusion of active learning activities. Active learning activities are defined as an action that requires a learner to apply didactic material into another application of materials. Examples include 'realia' case studies, simulation gaming, and narrative descriptions. Active learning activities are an illustration of constructivist learning. The constructivist approach to curriculum and instruction of a distance learning course can also direct students to create effective techniques of learning and studying. Constructivists believe that knowledge is constructed, not transmitted. Knowledge construction results from activity, so knowledge is embedded in activity. "Knowledge is anchored in and indexed by the context in which the learning activity occurs (Jonassen, et al., 1999, p. 3)." We can only interpret information on the context of our own experience. Knowledge building requires articulation, expression, or representation of what is learned. It is important for learners to engage in activities but they must also articulate what it meant.

Constructivism as an educational concept emerged in the last two decades of the twentieth century that this study seeks to research in rural medicine. Focusing on the nature of knowledge (epistemology) and learning, the theory regards the learner as the key player in constructing new ideas or concepts based on previous knowledge and new experiences. Constructivism encourages independent thought, creativity, and intuitiveness.

As described by Ornstein and Hunkins (2004), Von Glaserfield argues that there is some "looseness of fit" between what defines constructivism theory and constructivism as it is practiced in the contemporary classroom. He observes that constructivism manifests itself in the modern day classroom when students engage in some form of inquiry activity like the active learning activities required by ACPE. In other words, they construct knowledge by creating and testing their own hypotheses. They also explore their environment and question their knowledge to facilitate reflection.

Ornstein and Hunkins (2004) points out that some students might question the wisdom of constructing knowledge in face of the wealth of information that already exists. Ornstein supports the idea that individuals think in diverse ways: creatively, critically, reflectively and intuitively. He believes that it is imperative to incorporate the various mode of thinking in curriculum planning in continuing medical education. Ornstein maintains that to be truly constructivist, students should create their own structures of learning and instructional strategies.

Ornstein & Hunkins (2004) infer that problem solving, critical and reflective thinking skills that result from a constructivism learning model, equip students to deal with problems in other content area as well as challenging situations that they face in their everyday life. As students who had been accustomed to understanding concepts through trial and error, generating ideas and possible solutions by identifying available information related to a problem, it would be natural for them to apply the same techniques to any context. This was in contrast to traditional learning in which instructors transmitted verbal and concrete facts. Learners in a constructivist setting construct knowledge by exploring their environment and applying inquiry skills to create hypotheses and test ideas.

As facilitators of learning, this study seeks to develop continuing medical education that will discover techniques that include experiments and questioning in order to refine and develop students' inquiry skills like the active learning activities that are developed for each pharmacy course in the study. They should develop assessments that are supportive of collaborative learning, promote ownership in learning, as well as coach and guide learners who lack pre-requisite skills. This would have a great impact on the online education of students. As self-directed learners they will be motivated to pursue continuing medical education and to learn for the sake of learning.

Variable and Hypothesis of the Study

The study aims to determine the effectiveness of asynchronous learning on student performance, evaluate the affective response of student participation in asynchronous events, assess the distance learning techniques and methodology to provide asynchronous learning, and determine the qualities in a person that deems them a good candidate for a distance learning educational experience.

The asynchronous course delivery method is an effective distance learning technique to enhance student achievement in rural and under-served areas. This theory will be explored in the experimentation of the content in multiple modes of delivery. The experiments will lend to the testing of the pharmacists and pharmacy technicians on knowledge retention following the completion of the course.

All of the subjects in the study will be currently licensed pharmacists and pharmacy technicians seeking clinically-based continuing education units to maintain their state licensure. These subjects who complete the course requirements will receive ACPE approved continuing education credits.

The objective of the study is to provide effective asynchronous learning that applies instructional design as appropriate in the distance learning environment to increase the knowledge and apply

accreditation credits to respiratory therapists in rural and under-served areas. The technical objectives of the study are:

- Determine the qualities that make a pharmacist or pharmacy technician a good candidate for distance education
- Evaluate the affective response of student participation in distance education events
- Assess the distance learning techniques and methodology to provide continuing education for pharmacists and pharmacy technicians
- Determine the topics in pharmacy education that are in need of additional continuing education for pharmacists and pharmacy technicians in rural areas

Methods and Materials:

The courses are developed using html language to create web pages and the software Respondus and Studymate to create the assessments. The online delivery of the courses is completed with the learning management system WebCT and the pre-recorded sessions are performed with the virtual classroom software iLinc Learnlinc. The print courses are done so thru Microsoft Word and a printer. The research design states which method of delivery is used within each study experiment.

Lateral stratification of these professions (pharmacists and pharmacy technicians) will be necessary to facilitate the research. It will also demonstrate which professions, if any, have a greater demand for education, and which categories use the various methods of instructional technology. The study will also trend for age, gender, race, and location to study if any populations in the study are statistically significant. This information will be obtained by the affective assessment given to the study participants. This data will yield if a certain age group, or gender, or race, or rural location is statistically significant with one or more methods of asynchronous instruction at a distance.

An item analysis statistics will be performed to determine the validity and reliability of the tests for each continuing education program in the study. The quality of the test will be determined by the coefficient alpha (also known as KR20). A KR20 value of .5 or higher for each test item reflects to the extent to which the test would yield the same ranking of examinees if re-administered with no effect from the first administration, or its accuracy/power of discrimination. A very low KR20 will find any poorly written test items or very easy or very hard test items. This procedure will produce a psychometrically good multiple choice test from previous administrations of the cognitive assessments.

The statistical analysis of the discrete (nominal, ordinal) and continuous data (interval, ratio) obtained from the cognitive and affective assessments will be determined by parametric testing (independent samples T-test, One-Way ANOVA) to answer the research questions posed in the study. The measure of central tendency (mode, medium, and mean) will also be determined for each research hypothesis to determine any statistical significance. The three measures of variability (range, variance, and standard deviation) will be examined to determine any statistical significance. The level of statistical significance is a p value less than .05 or also known as alpha level. The measures of association will be examined for any statistical significance in correlation coefficients (-1.00 to +1.00). Any significant correlations will be plotted to illustrate a linear or curvilinear diagram. The correlation coefficient used in the statistical analysis will be the Pearson Product Moment correlation coefficient or also known as the Pearson-r.

Descriptive Statistics	
Instrument: Affective Assessment	Frequency Distribution
Age Gender Race Location	**Central Tendency:** Mean, Median, Mode, Sum **Dispersion:** Standard Deviation, Variance, Range, Minimum, Maximum **Distribution:** Skewness, Kurtosis
Analysis: The study population will be described by the statistical analysis of the central tendency, dispersion, and distribution of the subjects.	
Report: Any findings of statistical significance to describe the study group (determined by statistical interpretation)	**Analysis Chart:** Histogram for continuous data, Bar for discrete data
Independent Samples T-Test	
Instrument: Affective Assessment	**Instrument:** Cognitive Assessment
Age Gender Race Location	Test Score
Analysis: The student test score for each mode of delivery will be individually examined with the variables of age, gender, race, and location. This will be examined to determine if two unrelated samples come from the populations with the same mean.	
Report: Any findings of statistical significance (determined by the comparison of means)	**Analysis Chart:** Histogram for continuous data, Bar for discrete data

One-Way ANOVA (Analysis of Variance)	
Instrument: Affective Assessment	**Instrument:** Cognitive Assessment
Question 1 thru 6 Frequency distribution: 5 point Likert Scale	Test Score
Analysis: The questions (1 thru 6) on the affective assessment will independently serve as the dependant variable and the test score is the single factor for the analysis of variance. A Post Hoc multiple comparisons with Tukey equal variances assumed will be conducted to determine any statistical significance. This procedure will be repeated for each question in the affective assessment with the student's test score as the single factor for the multiple modes of delivery. The interpretation of the results will determine which	

method is of greatest statistical significance.	
Report: Any findings of statistical significance (determined by F ratio of the variance within the groups (error variance) to the variance between the groups (explained variance))	**Analysis Chart:** Histogram for continuous data, Bar for discrete data

Key Research Accomplishments:

Since this research study has not yet been deployed, there are no key data accomplishments to report at this time. However, a rather large key accomplishment to report is the completion of the course materials. The course materials developed are the syllabus, course directions, manuscript, and supplemental materials, learning activity, cognitive and affective assessments. Also, course space in the learning management system WebCT was developed to provide online access to the courses for students. This online course space not only contains the course materials but access to communication tools for students to communicate with each other and the instructor. In addition, a help function and access to WebCT technical support was developed to provide assistance to students. This help function includes online videos about commonly asked questions and access to a database full of answers and step-by-step explanations to common problems experienced by students.

Reportable Outcomes/Research Results:

Since this research study has not yet been deployed, there are no reportable outcomes or research results to report at this time.

Conclusions/Discussions/Lessons Learned:

This study is to research asynchronous distance learning methods delivered in various mediums to determine if any have a statistical significance among the groups in the study located in rural and under-served areas. The study also aims to determine the effectiveness of asynchronous learning on student performance, evaluate the affective response of student participation in asynchronous events, assess the distance learning techniques and methodology to provide asynchronous learning, and determine the qualities in a person that deems them a good candidate for a distance learning educational experience.

Due to the delay of data collection, this study has been extended for another year to accommodate the collection of data.

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Extensions/Stretch Goals:

This study will increase the number of accredited educational opportunities available to rural pharmacists and pharmacy technicians. These increases in the number of continuing education credits available will help assist in the prevention of rural pharmacists and pharmacy technicians from experiencing a lapse in their licensure. These online courses have the capability to overcome barriers found in rural locations and be examples of high-quality distance education.

This research will be continued to answer the study objectives of determining the qualities that make a pharmacist or pharmacy technician a good candidate for distance education while evaluating the affective response of student participation in distance education events. The study will also assess the distance learning techniques and methodology to provide continuing education. The topics that the study developed were found to be in need when examining the courses available to pharmacists and pharmacy technicians. This study also led to the investigation of new areas of required continuing education for medical professionals in the field of respiratory medicine. The results of this research will be extremely beneficial to others interested in how to provide online accredited education and to new areas of accredited learning, (such as respiratory medicine), on implementing the most effective methods of online instruction for maximum student learning and retention.

Appendices:

The text and multimedia materials (videos, photos, audio) developed in the study are available in print and online. To view these materials please contact the principal investigator of the study.

Specialized Medical Training

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Specialized Medical Training for Rural Medicine

Protocol No.: **05-TATDL203-05**

Date: February 2, 2007

Protocol Title: Specialized Medical Training for Rural Medicine

Principal Investigator: Kristine Anderson

Abstract:
This study will explore the utilization of specialized medical training in health education with physical therapy students at Saint Francis University in Loretto, PA. The effective use of streaming technologies will be determined in educating medical professionals by examining the method of delivery, pedagogic techniques, and display mediums. The visual learning technique is a modeling exercise where educators communicate to their learners to demonstrate proper execution of literary ideas. The active curriculum approach of engaging the learners into the content should spur personal experiences that the learner will gain a deeper interpretation from, instead of obtaining this knowledge from static resources.

Due to the delay in data collection, this study has been extended for another year to accommodate the next scheduled Special Topics physical therapy course offering in the spring semester of 2007. This collaboration with the course will experiment with technological ideas, functional actions, and to establish hypotheses on using technology to deliver healthcare education to rural and under-served areas.

Introduction/Background:

Introduction to the Problem
According to Sandholtz (1997), technology is a catalyst for change in classroom processes because it provides a distinct departure, a change in context that suggests alternative ways of operating. It can drive a shift from a traditional instructional approach toward a more eclectic set of learning activities that include knowledge-building situations for students.

The case study method of learning is a knowledge-building situation that has been around in a text form for sometime. The electronic presentation of a case study not only provides an interactive environment but is also a safe environment where any wrong decisions will not harm an actual patient. The case method presents a solution to giving medical professionals a hands-on approach to gaining experience with treatments of people with amputations.

This study will make a difference by addressing the reality of war. Currently, 28% of United States amputees are from the Iraq and Afghanistan wars (Moniz, 2005). In pale comparison, only 10% of American civilians have an amputation (Moniz, 2005). This doubling of amputees entering the American healthcare system has caused a strain on medical professionals needing additional training and exposure on the care and treatment of these patients. By working with rural physicians, orthopedic therapists, physical therapists, university instructors, Iraq and Vietnam veteran amputees, their families, and the National Naval Medical Center, this study will develop holistic continuing education for rural medicine. The continued development of this education will be delivered to currently-enrolled medical students and practicing professionals in Western Pennsylvania. In the future the study will partner with agencies such as the National Amputee Coalition to accomplish the project's goal of better care for war veterans.

Background

Instructors may struggle with meeting the diverse needs of students as they begin integrating technology into different areas of study. Direct instruction in the physical therapy classroom was holding the students back from an interactive method of learning and a paradigm shift is needed. Methods such as independent, cooperative and project-based learning opportunities are needed for students to be active rather than passive learners. (Land, & Jonassen, 2000; Johnson, Schwab & Foa, 1999).

The physical therapy class is an excellent pool of study subjects because the students will encounter the growing number of amputees from the Iraq war and will need more education on complications and treatments of amputation. The class will implement online course elements, interactive case studies, and handheld devices in the classroom for the first time. The study will investigate if the technology itself will cause new learning to occur, or if it is a combination of elements such as the Dexter study found when introducing curriculum elements of technology into the classroom.

Dexter (1999) conducted research involving several instructors from a variety of schools and states. They were investigating instructional philosophies, classroom technology use, and changes in teacher practice as they began using technology in their classrooms. The findings indicated that many instructors did experience changes but these changes appeared to not derive from any one source. Instructors made it clear that the technology did not automatically cause more constructivist practices. Several instructors moved towards the constructivist approach but stated it was because of teacher reflection, university-wide initiatives, and not simply because of the technology in their classrooms. The researchers did note that beliefs seemed to be changing as instructors shared that their thinking and learning had changed. Many instructors began to believe that students should be active not passive learners and with deep thinking, the instructors were experiencing gradual knowledge construction resulting in a shift of a teacher role. The main recommendation from this study was to frame instructors as agents of change and to not focus on the technology as the catalyst for change.

It is believed that in order for students and instructors to fully accept and implement a change in their classroom learning environment and teaching style, beliefs must also be altered (Saye & Brush, 1998). Nils, Peterson & Johnson (1999) addressed the difficulty of changing teaching practices. They said it involves reworking our belief system that is so ingrained from such an early age. The demonstration of an effective teaching practice such as the interactive case studies can establish examples and a route of implementing new learning strategies in the classroom. The orthopedic case studies on amputation considerations will be a new teaching strategy that takes into consideration the roles of the instructor and student in the classroom and the placement into the curriculum.

Purpose and Rationale of the Study

The purpose of this study is to measure the effectiveness of the delivery methods of online Internet page and online mobile device (handheld device) in continuing medical education, conducted over a one-year period at a distance to medical students and professionals in rural and under-served areas. Participants in the experiment will receive course contents over the Internet or on handheld devices using features such as Internet-based case studies, examinations, and cognitive questionnaires.

All of the subjects will be currently practicing medical professionals or medical students seeking clinically-based continuing education. These subjects who complete the course requirements will successfully complete each case study. The subjects in the study will be competent to provide informed consent and under no physical risk in any course of study.

Distance education could be a solution to a wide variety of problems in education. The field of specialized medicine will determine if streaming media online can be an educational solution for health education to rural and under-served areas. Health education at a distance has to connect learners and deliver course content (Gay & Airasian, 2002). The objective of this protocol is to effectively communicate the pedagogic ideas in a subject effectively by using distance learning technologies, such as learning management systems and virtual classroom software, to support the content (Norris, 1998). This study will respect the proper consideration of the audience receiving streaming technologies and limitations of its Internet infrastructure. The process of bringing specialized medicine training to rural areas is a large task that involves researching emerging technologies and the technical knowledge of the subjects.

The protocol study in the FY05 year developed several text course materials. The multitude of multimedia materials developed are available online for viewing at: http://courses.cermusa.francis.edu/ortho/index.html. These materials were developed by a physician and by referencing medical texts concerning amputation. The evaluation of the materials with subjects was delayed due to a delay in obtaining IRB approval from the U.S. Army Medical Research and Materiel Command's Human Subjects Research Review Board. In addition, Saint Francis University offers the physical therapy course once a year, thereby missing the window of opportunity to conduct this study in due time In the FY06 year, the amputation case studies will be tested with the physical therapy students using the research design described below. Also in the FY06 year, the protocol will seek to design effective educational offerings on continuing education with chronic disease for medial professionals. The FY06 year will incorporate educational materials developed in the Continuing Distance Education for Rural Pharmacists (05-TATDL202-05) protocol, the amputation case studies materials, and the materials to be developed that address understanding, prevention, and patient self-care for chronic diseases. These educational materials will be evaluated using the study's research design.

Variable and Hypothesis of the Study

The technology enhancement of specialized medical training will develop the knowledge of rural health professionals. This theory will be explored in the experimentation of the medical content in multiple modes of delivery including Internet and handheld devices. The experimentation will lend to the testing of the medical professionals on knowledge retention following the usage of the education. This will measure the intrinsic worth of the training in regards to the medical professionals.

Lateral stratification of these medical professions will be necessary to facilitate the research. In other words, the subjects will not be grouped by their profession. This will also demonstrate which medical professions, if any, have a greater demand for education, and which professions use the various methods of instructional technology used in the study.

The study's objective is to provide effective asynchronous and synchronous learning that applies instructional design as appropriate in the distance learning environment to increase the

knowledge and apply educational training to medical professionals in rural and under-served areas.

- Define and research the enactment of various pedagogical theories of effective medical education in rural and medically under-served areas.
- Research the technological appropriateness of medical training in rural and medically under-served areas.
- Research future technologies that have the potential for delivering education to rural medical professionals.

Methods and Materials:
The Orthopedic case studies are developed using html language to create web pages and the assessments. The cases are developed with administrator and student logins to edit and participate (respectively) in the case studies. The videos, sounds, and photographs in the case studies were developed and edited in CERMUSA's Distance Learning Prototype Laboratory. The multimedia elements of the case studies (videos, photographs, sounds) were placed on handheld devices for testing with study subjects. The research design states which method of delivery is used within the study experiment.

The survey items on the affective assessment and the test items on the cognitive assessment will be analyzed and reported using descriptive statistics (frequency distribution and graph). This will be done for each mode of delivery in the study (Internet and mobile handheld device). The statistical protocols that will be used in the study are in the table below.

Descriptive Statistics	
Instrument: Affective Assessment Cognitive Assessment	Frequency Distribution
Survey Items Test Items	**Central Tendency:** Mean, Median, Mode, Sum **Dispersion:** Standard Deviation, Variance, Range, Minimum, Maximum **Distribution:** Skewness, Kurtosis
Analysis: The study population will be described by the statistical analysis of the central tendency, dispersion, and distribution of the subjects.	
Report: Any findings of statistical significance to describe the study group (determined by statistical interpretation)	**Analysis Chart:** Histogram for continuous data, Bar for discrete data

The research will address the technical objectives of the study that define and research the enactment of various pedagogical theories of effective medical education, research the technological appropriateness of medical training, and research future technologies that have the potential for delivering education to rural medical professionals. The objectives will be researched through the testing of the technologies and learning theories to develop the continuing

education at a distance courses. This in combination with a literature review and document analysis will provide data to respond to the technical objectives of the study.

The data for this study will be collected by the affective and cognitive assessment given to the subject that completes a case study or learning event using one of two methods of delivery: Internet and mobile device (handheld device). The assessments will seek to answer the technical objectives of the study and the question: Is there a significant difference between the delivery methods of online Internet page and online mobile device (handheld device) in continuing medical education at a distance to rural medical professionals? The subjects will be randomly chosen to use each mode of delivery.

The affective assessment will gather a subject's thoughts and opinions regarding the educational event they just completed. The cognitive assessment will gather what they have learned and what areas still need to be reinforced for understanding. The study will measure success by the analysis of the research question below. The measurement of the outcomes of the experiment will be measured and reported by descriptive statistics (frequency distribution and graph).

Key Research Accomplishments:
Since this research study has not yet been deployed, there are no key data accomplishments to report at this time. This study is to be performed with Saint Francis University physical therapy students in the spring 2007 semester. The study was to be done with the spring 2006 semester, but was delayed due to seeking IRB approval. However, a rather large key accomplishment to report is the completion of the case study materials. The text materials developed are available and the multimedia developed is available online.

Reportable Outcomes/Research Results:
Since this research study has not yet been deployed, there are no reportable outcomes or research results to report at this time.

Conclusions/Discussions/Lessons Learned:
This study is designed to determine if there is a significant difference between the delivery methods of online internet page and online mobile device (handheld device) in continuing medical education at a distance to rural medical professionals. The study also seeks to research the enactment of various pedagogical theories of effective medical education in rural and medically under-served areas, research the technological appropriateness of medical training in rural and medically under-served areas, and research future technologies that have the potential for delivering education to rural medical professionals.

Due to the delay of data collection, this study has been extended for another year to accommodate the collection of data.

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Extensions/Stretch Goals:

The online delivery method of education may be an effective method to enhance the classroom curriculum by providing students and instructors with interactive materials that demonstrate didactic concepts. This study will implement, for the first time, online case studies with multimedia elements that illustrate information on orthopedic topics in patients with amputations. The orthopedic case studies also contain a large electronic library of information that is available anywhere with an Internet connection. These online case studies are illustrative examples of the innovative use of technology to enhance the traditional classroom.

In the future, the results of this demonstration level study with a class of physical therapy students will be applied to a larger audience. The orthopedic case studies will be tested with practicing medical professionals and the cases will be developed further to include more types and complications of amputations. Also, the amputee case studies will include different treatment options for students to study. These new elements include a lesson on how social workers provide assistance to a person with an amputation and why psychologists provide mental health services for syndromes like Post-Traumatic Stress Disorder.

Since the majority of non-traumatic amputations are due to the chronic disease of diabetes, the specialized medical training protocol will develop online interventions and information about treatment and self-care of chronic diseases.

Appendices:

The text and multimedia materials (videos, photos, audio) developed in the study are available in print and online. To view these materials please contact the principal investigator of the study.

Delayed Clinical Training for Tropical Medicine

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: The Effectiveness of Delayed Clinical Training for Tropical Medicine Education

Protocol No.: **05-TATDL204-05**

Date: February 2, 2007

Protocol Title: The Effectiveness of Delayed Clinical Training for Tropical Medicine Education

Principal Investigator: Gabrielle M. Cronin, M.Ed

Abstract:
The Military Tropical Medicine course is a Tri-Service course involving students from all military branches. There is a 4-week didactic/lab component that is taught in residence by the Naval Medical Education and Training Command (NMETC). Following this didactic portion, some of these students travel to four or five different sites for a two week clinical rotation, during which they have the opportunity to utilize the skills and medical specialty knowledge base taught in the course. Since the number of sites where this clinical program can be implemented is limited, some students would experience a delay between their didactic and clinical experiences. This research protocol will evaluate the effect that the delay has on student learning outcomes and knowledge retention. Additionally, we will determine if providing the cognitive knowledge in spaced repetitions will help to retain the knowledge. Educational interventions will be given to the study participants in the experimental group only. Cognitive measurements will be taken at two times, the end of the didactic portion of the course and immediately before the clinical rotation. The result of these cognitive assessments will be compared and analyzed.

Due to the delay in the start of data collection, this protocol has been extended for another year to accommodate the next scheduled Military Tropical Medicine course offering in July 2007.

Introduction/Background:
The field of medicine is complex and requires a great deal of knowledge. Medical professionals must develop both cognitive and clinical abilities on a wide range of medical diseases and conditions. Some of these diseases and conditions are common and seen regularly; others are rare, therefore seen occasionally. Nonetheless, medical professionals must be knowledgeable and react quickly and decisively to medical emergency situations.

Medical education is primarily based on providing didactic education, where the students gain cognitive knowledge on diseases and conditions, coupled with clinical experience, where the students apply their cognitive knowledge in a 'hands-on' experience. In specialty medical fields, such as tropical medicine, students may experience a delay between when they gained the clinical (cognitive) knowledge of the disease to when they have 'hands-on' experience with the disease state. Without constant application of the knowledge, students may have a decrease in retention, and thus, transfer of the knowledge and skills in the field. Educators are faced with the need to augment this learning in an effort to decrease the learning deficiency. In this research protocol, we will determine best practices in providing educational interventions between the didactic and clinical portions of the course. An educational intervention, based on the same content, but on the different cognitive levels of Bloom's Taxonomy (Bloom, 1984), will be developed to augment the students' knowledge. With these educational interventions we will analyze the spacing effect and retention intervals to determine the appropriate timing intervals and sequencing patterns for knowledge retention and comprehension.

The spacing effect has been studied for many years. Spacing effect is the memory benefit that individuals accrue when they increase the duration between practice episodes (Pavlik and Anderson). In another study, Thalheimer found that presenting repetitious learning improves retention up to 40% and is more beneficial for long-term learning (2003-2004). Sheabrook,

Brown, and Solity (2004) have proven that effectiveness of teaching is improved by increasing the distribution of the lessons. A research study on traumatic brain injury individuals proved that the applying of the spacing effect during learning can significantly improve recall and retention (Hillary, et all 2003). In recent studies investigating knowledge retention, Bahrick and Hall (2005) reported that long intervals between study sessions yield substantial benefits to long-term retention.

CERMUSA, in collaboration with Navy Medicine Manpower, Personnel, Training and Education Command (NAVMED MPT&E), will be investigating the spacing effect, more commonly known as distributed practice, within a technology and web-based environment. Since specialty medicine requires long-term memory retrieval, we will determine if providing the cognitive knowledge in spaced repetitions increases the retention of the knowledge. We will also determine the appropriate amount of space between repetitions.

The amount of time the student retains the information, knowledge, or skill is referred to as the retention interval. According to Semb and Ellis (1994) retention is affected by length of time and what occurred during the interval. Here we will evaluate the students' retention before they begin their clinical rotation to determine the effect of the educational intervention provided to the experimental group.

The purpose of this research study is to determine the effect that a physical delay between didactic and clinical experience has on student learning outcomes. The research objectives for this study are to:

- Improve learning outcomes and knowledge retention through the application of an externally paced educational intervention during a three or six month interval as measured in a cognitive assessment.
- Evaluate externally paced delivery to determine appropriate timing and sequencing patterns for the educational intervention.

Methods and Materials:

The Military Tropical Medicine course is a Tri-Service course involving students from all military branches. There is a 4-week didactic/lab component that is taught in residence by the Naval Medical Education and Training Command (NMETC). Following this didactic portion, some of these students travel to four or five different sites for a two week clinical portion. During their clinical rotation, some students have the opportunity to utilize the skills and medical specialty knowledge base taught in the course while others may not have that experience.

This protocol is designed to determine the effect that a physical delay in time between the didactic and clinical portion of the course has on student learning outcomes. Additionally, this research study will determine what effect the provision of educational interventions has on student achievements and knowledge retention.

The Military Tropical Medicine course is offered annually in the month of July. We were unable to implement the research study with the 2006 student population because the IRB approval to perform the study was not approved on time. The research protocol was initially submitted September 2005. In May 2006, a Memorandum for Record was received with recommendations to revise the protocol. The research protocol was revised accordingly and re-submitted. The research protocol was then sent for a second scientific review. In September 2006, the second

scientific review was returned with minor revisions prior to IRB approval through U.S. Army Human Subjects Research Review Board (HSRRB).

During the IRB approval process through HSRRB it was discovered that the NAVMED MPT&E investigators would need to obtain a Department of Defense (DOD) assurance for the research study. Additionally, the Bureau of Medicine and Surgery (BUMED) would need to provide a read on the research protocol since the study is targeting a specific audience of commissioned military doctors. All of the necessary standard forms have been developed, signed, and submitted to BUMED. As a result, this research protocol has been extended for another year to accommodate the next scheduled Military Tropical Medicine course offering in July 2007.

Meanwhile, we have begun the development of the educational interventions. Based on the feedback from previous student populations, six topics (Risk assessment/communication to senior non-medical leaders, HIV, Malaria, Dermatology, Schistosomiasis, and Hepatitis B & C) have been identified. Therefore, educational interventions for each subject will be developed based on the content present in the course materials as well as material available in "Hunter's Tropical Medicine and Emerging Infectious Diseases" textbook.

Key Research Accomplishments:
Since this research study has not yet started, there are no research accomplishments to report at this time. We believe that the findings and data collected through this paradigm will have an impact on other training methods and provide best practices in keeping students knowledgeable on specialty skills learned but rarely applied in the USA.

Reportable Outcomes/Research Results:
Since this research study has not yet been conducted, there are no reportable outcomes or research results to report at this time.

Conclusions/Discussions/Lessons Learned:
This protocol is designed to determine the effect that a physical delay between the didactic and clinical portion of the course has on student learning outcomes. Additionally, this research study will determine what effect the provision of educational interventions has on student achievements and knowledge retention.

Due to the delay in the start of data collection, this protocol has been extended for another year to accommodate the next scheduled Military Tropical Medicine course offering in July 2007.

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Extensions/Stretch Goals:

Occupying the gap between the end of the learning event and the performance event with instructional content that is spaced over time and delivered in different contexts may increase cognitive retention and transfer and improve performance. The intent of this study is to assist educators in keeping medical professionals knowledgeable on diseases that are not commonly seen on a day-to-day basis. The results of this intervention could have an impact on other training and provide best practices in keeping students knowledgeable on specialty skills learned but not applied everyday.

In the future, we wish to utilize the lessons learned through this study and apply them to the field of first responders and medical response. There is an ongoing need to train and prepare healthcare providers to respond in a multidisciplinary approach to terrorist acts and other public health emergencies. First responders are required to take an Awareness Training course preparing them for mass casualties and incidences involving weapons of mass destruction. However, they may not face a situation in which this training prepares them for years, or never. The provision of educational simulations and interventions spaced over time may increase the retention of this vital training and education.

Appendices:

There are no relevant appendices to include at this time. Once data collection begins, we will have reportable results to share and document.

Supporting Data:

Since this research study has not yet been deployed, there are no research findings to report at this time.

Broadband Infrastructure

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Developing Broadband Infrastructure for Rural Areas

Protocol No.: **05-TATDL205-05**

Date: February 2, 2007

Protocol Title: Developing Broadband Infrastructure for Rural Areas

Principal Investigator: James F. Gerraughty

Abstract:
This protocol was designed to encompass all of the communications technology that CERMUSA currently works with and also provide a means to expand into future communications technologies such as Broadband over Power Lines (BPL), WiMAX (802.16/802.16a), 802.11n, and others. The resulting research would not only provide data for what technologies work best in rural environments, but also best practices in the choosing of appropriate, both fiscally and technologically speaking, technologies for telehealth and distance learning applications, with specific applications into patient simulations and gaming for medical education. The term broadband applies to connection with speed of 2 Megabits/second (Mbs) or higher.

Results of the project and research were inconclusive due to delays in approval from the U.S. Army's HSRRB's IRB. The delays pushed back the effective starting date, which in turn resulted in there not being enough time to implement research plans. However, the research is planned to go forward in FY06, encompassing medical Spanish instruction, remote student teacher monitoring, and immersive segmentation for medical education.

Introduction/Background:
CERMUSA has been researching wireless communications technology for several years. This protocol will have a foundation in the past research of the Wireless Campus, Rural GigaPoP, Portable and Mobile Classroom, and the Mobile Communication Platform protocol (CERMUSA, 2004 and Grok, 2003). In the past, CERMUSA has utilized dial-up speeds for delivery of content, often to find that the content was limited to basic applications. This was due to the constrictions of dial-up. The application of broadband in education is an evolution from dial-up research in the past, due to more commercial and off-the-shelf broadband technology.

A second research element will involve Internet2. Internet2 is a research entity of schools and corporations that runs on a high speed data network known as the Abilene Network. Portable commodity Internet and Internet2 methods are currently being utilized (OARNet, 2005); however, nothing has been utilized in rural areas. Research opportunities from virtual dissection to language education to shared computing are present within Internet2. CERMUSA joined Internet2 in 2003 and has done research with patient simulation at the Naval Health Research Center - San Diego and participated in Internet2 conferences.

Hypothesis
The hypothesis is that broadband access in rural areas will augment learning and training in both the medical and educational fields. Through surveying end-users and working within educational plans, CERMUSA will prove or disprove this theory. The second part of the research will provide a potential path for future development. Broadband connectivity had been making its way into rural areas, most notably publics schools and hospitals. The purpose and rationale for the research is to determine what broadband technologies can be effectively deployed in rural areas, with regards to cost and educational merit. The variables to be considered are the means of transmission and its appropriate uses, as well as the educational content itself.

Methods and Materials:
The study was initially planned to be a quantitative study using students in the Physical/Occupational Therapy Departments and Physician Assistants Department at Saint Francis University and a patient simulator. Criteria for inclusion/exclusion will be determined by the student. Should the subject not want to participate, then the subject will not be enrolled in the study. Subjects will have the option to not participate in the research after the start of the protocol, should circumstances mandate.

The subjects will be asked to participate in patient simulations and divided into groups. One group would be at the simulator, the other would be learning at a distance. Data from tests and surveys would have then been collected and analyzed to prove or disprove the hypothesis.

It has been decided to amend the protocol in FY06 to cover medical Spanish and remote student teacher instruction, as well as the patient simulator.

Key Research Accomplishments:
At the time of writing, there are no research accomplishments, save for some testing and technical requirements. However, the research study will continue into FY06, thus providing research data.

Reportable Outcomes/Research Results:
As stated above, there are no outcomes or results. With the progression of research into FY06, however, the primary researcher believes data and resulting outcomes will occur.

Conclusions/Discussions/Lessons Learned:
No conclusions were reached due to the delay of approval from the U.S. Army's HSRRB's IRB. The delays pushed back the effective starting date, which in turn, resulted in there not being enough time to implement research plans. However, the time was used to further refine the research project for FY06, as is stated in the Methods and Materials section.

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Extensions/Stretch Goals:
Despite having the delay to the research, the primary researcher believes that studies like the Developing Broadband Infrastructure for Rural Areas project will aid future research projects in determining appropriate content in high-speed data environments and appropriate communication deployment into rural areas. Examples of future research could be:

- Further specification of the types of classes that can be taught. An example would be that medical Spanish was researched, and this could lead to medical Vietnamese, medical Arabic, or medical Mandarin Chinese (both languages have tonal variations that can affect translation).
- Refinement of the content delivered in order to minimize technical errors and maximize educational value. The research would be backed up by cognitive assessments.

The significance of the research to both rural healthcare and general knowledge is twofold: It is found in the delivery of education, and in the quality and efficacy of the content. Not all rural healthcare providers and hospitals have resources like their urban counterparts (university connections, revenues). The content delivered over a broadband connection can start to level out the playing field for those at the rural end of the spectrum. That isn't to say that high-speed connections for rural hospitals are a panacea for educational ills: The content has to be of good quality or the technology and the student's time has been wasted.

Appendices:
There are no appendices for this report.

Supporting Data:
There is no supporting data this time.

Wireless Testbed

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Technical Report

Protocol Name: Wireless Testbed

Protocol No.: **05-TATTH206-05**

Date: February 2, 2007

Protocol Title: Wireless Testbed

Principal Investigators: Kent Tonkin, David Wolfe, James Makin

Abstract:
The CERMUSA Wireless Test Bed is an open-architecture technology proving ground capable of evaluating a wide variety of wireless applications. The mission of this facility is to test and evaluate new and emerging wireless technologies including, but not limited to, licensed high power VHF & UHF Land Mobile Radio, 900MHz, cellular, 2.4 & 5.8GHz WiFi, ad-hoc mesh networks, LOS microwave, and mobile satellite communications. Originally developed to support such protocols as the First Responder Emergency Communications-Mobile (FREC-M) project, the Wireless Test Bed will begin to explore more modular types of communications in 2006, including rapidly-deployable, self-healing wireless networks. Our preliminary work presented here suggests that this is a workable approach.

Background
The Wireless Test Bed Protocol was created to experiment with various wireless technologies and methodologies in order to determine those which would function well in rural America. Central Pennsylvania is an ideal location for wireless testing activities, as it is home to vast expanses of sparsely populated areas, in an environment of rough terrain and unpredictable weather patterns. In these areas, users of both commercial and emergency services wireless communications networks in many parts of the state are often hindered in their efforts based on "blackout" zones where no connectivity is possible.

Based in a five-mile radius around the rural town of Loretto, PA, the CERMUSA Wireless Test Bed is both a proving ground for wireless technologies to be deployed in other CERMUSA protocols and an independent evaluation facility for "stand-alone" applications. This test bed provides an open technology architecture that can be modified to test fixed and mobile communications and data applications. More specifically, it provides an infrastructure for evaluating communications/data transmission devices, radios (licensed and unlicensed band), high-speed "backhaul" communications technologies (RF, Spread Spectrum, laser, satellite, and microwave), and other medical data devices, in a region that is significantly underserved by commercial providers of wireless telecommunications services.

The need for this kind of research has been blatantly underscored in recent years through emergency situations in the United States. The 2005 Hurricane Katrina disaster revealed serious inadequacies in communications systems interoperability within individual responder groups and between various agencies. For example: National Guard Units were communicating via handwritten notes carried by couriers between locations (Walsh); and several first responder units gave up on high-tech satellite phones in preference of pre-paid cellular telephones (Piazza).

The problem of interoperability is not limited to national disaster response. A June 2004 survey by the United States Conference of Mayors, including 192 cities in 41 states, revealed that 75% of respondents reported that cross-agency communications were hampered by interoperability issues. Additionally, 88% of respondents stated that their communications equipment was incompatible with federal systems (Piazza).

New technological advancements may be paving the way to more robust, reliable, and redundant communications. Long lauded as a military-only application, software defined radios (SDRs) may enable digital devices, such as cell phones, to be repurposed and/or upgraded to fit a specific need (InTech). Rapidly deployable stand-alone communications networks are also becoming more viable. Several companies, including Strix Systems, are developing hybrid approaches, combining a satellite "backhaul" with local wi-fi service in a low-profile system. Such systems can be dropped into place for the establishment of temporary communications infrastructure (Knape, 2005).

Still other approaches and applications may make use of existing infrastructure to cross-connect disparate communications mediums. Several vendors have established automatic calling systems which will inform residents and emergency response professionals via massive simultaneous one-way telephone calls (Mayes). Additional multi-format communications standards, such as Common Alerting Protocol (CAP), allow messages to be sent to multiple wired and wireless devices, ensuring quick dissemination of information over various pathways (Wolf, 2005).

This year, in response to both the growing maturity and scope of national and international endeavors in emergency response wireless communications, the CERMUSA Wireless Test Bed will focus on placing "bridge"-type technologies, as deployed in other CERMUSA studies, into portable form-factors. As such, our main focus shall be in the creation of a mesh nework utilizing and rapidly deployable emergency communications suite.

Mesh networks are communications systems in which all nodes are capable of communicating with each other (Frenzel, 2005). This configuration makes mesh networks ideal for deployment in both military and public safety applications, and other situations where point-to-point communications in a dispersed arrangement are necessary (Frenzel). Cities such as Providence, RI, are already recognizing the value and resiliency of mesh systems as a viable infrastructure for police and EMS (Hamblen, 2006).

1. **Swarm model of wireless networking:**
   Concept:
   CERMUSA proposes to test the use of multiple types of rapidly-deployable networking technologies, including self-healing Mesh networks, to provide connectivity for civilian emergency response. This testing would consist of the evaluation of multiple types of inter-operable networking devices that could be deployed using a variety of methodologies. An example scenario could include the combined use of air-dropped network access points, remote controlled robotic access points, and vehicular command stations to create functional networking in a disaster scene.

2. **Deployment of low cost relocatable aerial and ground-based wireless networking:**
   Concept:
   This project will serve as a more in-depth expansion of the SWARM model by relying more heavily on robotic components. CERMUSA proposes to test the financial and technical feasibility of using balloons and other aerial suspension techniques to elevate wireless access points to provide greater coverage over wide terrain. This testing will examine which networking standards function best via such a deployment medium and will also explore practical and inexpensive power sources (e.g. solar). Additionally, CERMUSA proposes to

further explore current efforts to use unmanned ground vehicles for "remote control" expansion of wireless networks by using the vehicles themselves as access points.

Hypothesis:
Rapidly-deployable, self-healing networks (Mesh) can be created from commercial-off-the-shelf components and be deployed in rugged and austere environments.
These networks will have a small form factor and be useful in tactical settings.
COTS-based robotic or remote control platforms will be useful in extending the reach of these networks.

Objectives:

- Perform market analysis
- Evaluate results from similar research efforts
- Identify necessary technical components
- Begin system build
- Perform laboratory testing
- Perform outdoor testing
- Modify Mesh network to accommodate robotic/remote control network extensions

Technical Objectives:

- Research commercially-available components for production of rapidly-deployable Mesh network components.
- Perform research to garner new ideas and avoid repetition of established research
- Assemble components list for system build
- Build Mesh network system from COTS equipment
- Conduct testing in laboratory setting to include: throughput, layers of Mesh association, maximum distance between nodes, fault tolerance, etc.
- Conduct testing in outdoor setting to include: throughput, layers of Mesh association, maximum distance between nodes, fault tolerance, etc.
- Mount one or more Mesh access points to mobile robotic devices (ground or aerial) to extend reach of network as well as ability to control robot via carrier network.

Methods and Materials:

1. **Swarm model of wireless networking**

Specific technologies:
CERMUSA anticipates making extensive use of non-licensed 802.11 technologies, but other licensed technologies may also be deployed, as the current wireless test bed backbone supports both VHF & UHF licensed frequencies. In addition, CERMUSA anticipates the use of commercial off-the-shelf robotics platforms such as iRobot Packbots, OEM-style development kits, and custom-developed low-cost solutions from partnering agencies (such as TATRC, Drexel University, and Carnegie Mellon University).

Research methodology:
This research will be fundamentally quantitative. Each component technology will be individually evaluated to verify functionality within manufacturer's specifications (i.e.

transmission distance, data throughput, etc.). Following completion of initial testing, components will be assembled based on demonstrated best practices (where possible), as documented by other research. Where such research is NOT available, CERMUSA will attempt multiple methods of approach and document results based on quantifiable research criteria.

The overall goal of this project is to evaluate wireless network coverage improvement in a given area when the Swarm model is deployed. Swarm networking involves the use of multiple types of rapidly-deployable networking technologies, including self-healing Mesh networks, to provide connectivity for civilian emergency response. This configuration can consist of of multiple types of inter-operable networking devices that could be deployed using a variety of methodologies. An example scenario could include the combined use of air-dropped network access points, remote controlled robotic access points, and vehicular command stations to create functional networking in a disaster scene. Coverage will be evaluated by phases; as each type of network device is deployed, the overall network coverage will be measured by a topographical grid. Once each type of network device is measured separately, all types will be simultaneously deployed and measurements will be repeated.

Coverage at each phase will be compared to pre-Swarm coverage to determine the efficacy. Network throughput will be evaluated in each grid slot based on total Mbps available using portable-computer-based bandwidth monitoring tools. File transmission and download speed will be measured using multi-megabit files. All measurements for each phase will be sorted via spreadsheet and converted into topographical coverage maps.

2. **Deployment of low cost relocatable aerial and ground-based wireless networking**
Specific technologies:
As with the aforementioned Swarm project, CERMUSA anticipates making extensive use of non-licensed 802.11 technologies; other licensed technologies may also be applied where relevant. CERMUSA anticipates the use of commercial off-the-shelf robotics platforms such as iRobot Packbots, OEM-style development kits, and custom-developed low-cost solutions from partnering agencies (such as TATRC, Drexel University, and Carnegie Mellon University).

Research methodology:
This research will be fundamentally quantitative. Following initial assembly testing, components will be assembled based on demonstrated best practices (where possible), as documented by other research. Where such research is NOT available, CERMUSA will attempt multiple methods of approach and document results based on quantifiable research criteria. CERMUSA anticipates that start-up phases of this project will necessitate extensive interaction with product developers, as many of the devices may be "beta" versions requiring extensive support.

The overall goal of this project is to evaluate wireless network coverage improvement in a given area through deployment of single unmanned ground vehicles (UGVs) or unmanned aerial vehicles (UAVs). Coverage will be evaluated based on distance and terrain; as each type of robot is deployed with a wireless repeater, data transmission will be measured by a topographical grid. Operators will remotely move the vehicle further and further from a set

evaluation point until data transmission is no longer possible. This method will be repeated over varying forms of terrain (or wind conditions for UAVs) to identify the best practices for the extension of remotely-controllable WLAN extensions. Results from this project will likely feed into the Swarm project. All tests were to be conducted multiple times using the same technologies and data gathering forms in various locations.

Results of the Research:
CERMUSA Wireless Testbed staff kicked off this project in March 2006 to begin selecting candidate technologies for the construction of a rapidly-deployable self-healing mesh network. Based on the goal of creating this network, the group decided on the following work plan:

1. **Conduct market survey of commercially available ruggedized mesh network equipment.**
   - A market survey was performed to find what equipment was already available to the general public. Several companies had WiFi access points for sale which included some sort of mesh architecture. Most units were in weather tight metal boxes meant to be permanently mounted to roof tops or telephone poles and provide a mesh network to blanket a few city blocks or an entire town with WiFi access.
   - CERMUSA technical staff found only one type of mesh box built for rapidly-deployable tactical use: The Bread Crumb. The BreadCrumb is a ruggedized mesh network box designed and built by Rajant Corporation. It features an 802.11b architecture both for backhaul and client connection built inside a weatherproof Pelican case. The access point provides 200mW of transmit power and can run for several hours from the internal lithium-ion battery pack. Antennas are located inside the box. A power switch, external Ethernet jack, and external antenna jack are located on the outside of the box.
   - Despite the solid construction and competitive feature set of the Bread Crumb product, CERMUSA technical staff found the device to be cost prohibitive ($5000 per unit and up, depending on options) and to be lacking in some desirable feature sets (redundant power, additional backhaul frequencies, etc)

2. **Design an improved version of currently available technology.**
   - CERMUSA sought to design a much-improved version of the BreadCrumb box. We wanted the following criteria in the boxes we manufactured in-house.
     1. 802.11a/b/g access point with mesh architecture. The access point must have external antenna connections, a wired Ethernet connection, and operate on 12 Volt DC power or less.
     2. Weather-proof enclosure to resist dust, moisture such as light rain, and shock.
     3. Several redundant power supplies to include internal batteries, a solar panel, external battery connection, AC power supply, and a battery charging system.
     4. Externally mounted antennas.
     5. Bi-directional amplifiers on each access point radio to extend the range far beyond what a traditional access point can cover.
     6. Simple toggle switch "power-on" and quick setup.

3. **Research mesh enabled access point market for the core backbone of our network design.**
   - CERMUSA conducted research into types of commercially available access points that would fit our requirements for the core of our ruggedized mesh network boxes. We looked at boxes from Mushroom Networks, Proxim, Firetide, Motorola, and Strix Systems among others.
   - Proxim's AP-4000M line of mesh-enabled access points satisfied all initial requirements. They were small enough, approx. 8" x 5" x 1", to fit in our planned rugged case, required low voltage and current, had an Ethernet jack, and two external antenna jacks for both 802.11a and 802.11b/g. The mesh architecture could function with either 802.11 standard being the backhaul between units and the other standard being used for client connection to the boxes. Keeping the backhaul network traffic and client traffic on separate bands would maximize throughput of the mesh network instead of everything being on an 802.11b backbone and having to share 11Mbps throughout the mesh.
   - Network design: In order to tie into CERMUSA's LAN and WAN systems, this mesh architecture required a physical gateway box. CERMUSA technical staff selected a multipurpose cellular gateway from InMotion Technology, Inc. to satisfy this requirement. In addition to bridging our stand-alone mesh WLAN into the core CERMUSA LAN, this gateway was also capable of using an integrated PC cellular card interface to provide Internet access from up to two commercial providers. Test bed staff felt that integration of this capability would add to the overall utility of the system and allow it to be deployed independent of the CERMUSA LAN.

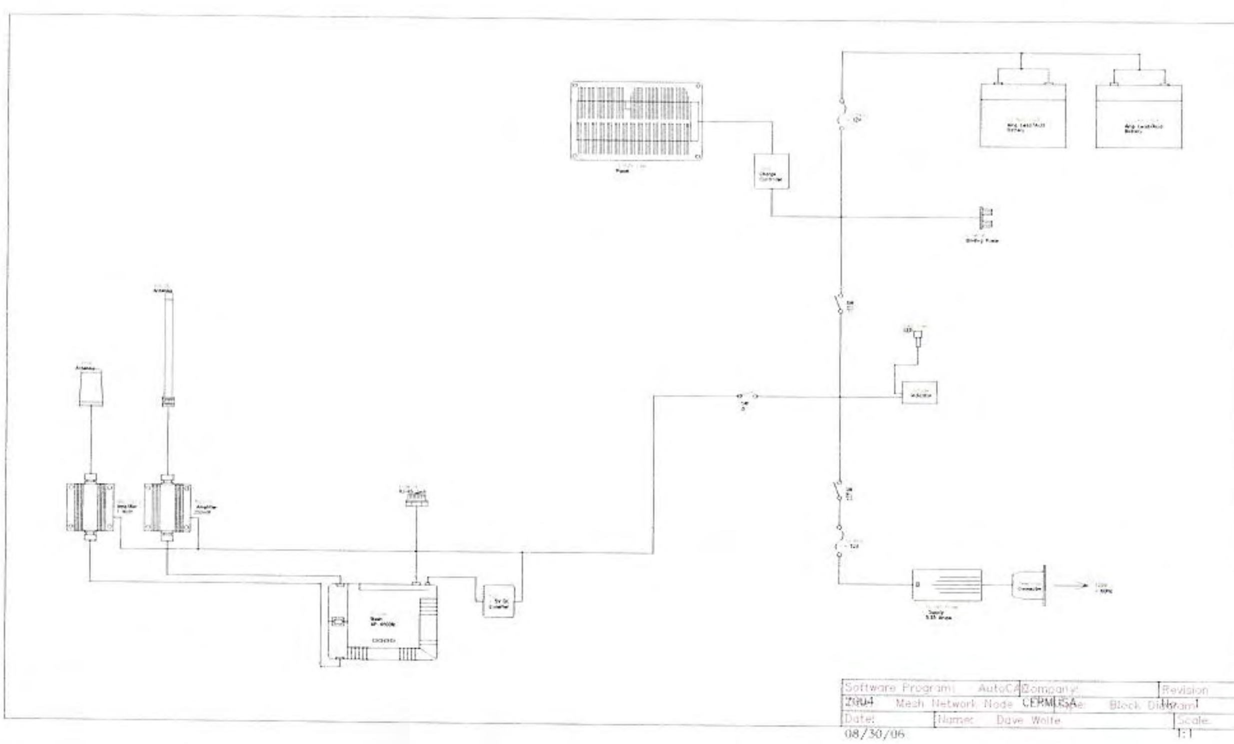
4. **Design weather resistant modular packaging to house the components with redundant sources of power.**
   - Pelican cases were chosen for the mesh network box housing. Pelican cases are natively waterproof, shockproof, and air-tight. CERMUSA technical staff evaluated these boxes as far superior to any other plastic case on the market.
   - All electronic equipment was mounted inside the box with heavy-duty Poly-Lock adhesive Velcro or silicone caulking.
   - A heavy-duty Twist-Lock power connector, waterproof Ethernet jack, 12 volt "banana" power jacks, two vehicular type antenna jacks, three heavy-duty covered toggle switches, and a ruggedized solar panel were mounted to the outside of the Pelican case.
   - The ability of the box to be waterproof and air-tight when closed has been removed due to the many holes drilled in the exterior for mounting equipment. The box remains weather resistant.

5. **Purchase all equipment needed.**
   - Listed below are all major pieces of equipment purchased for each box.
     1. Proxim AP-4000M Mesh Access Point.
     2. RF Linx 802.11a/b/g bi-directional amplifiers.
     3. Comtelco 5.8GHz 8dBi antenna.

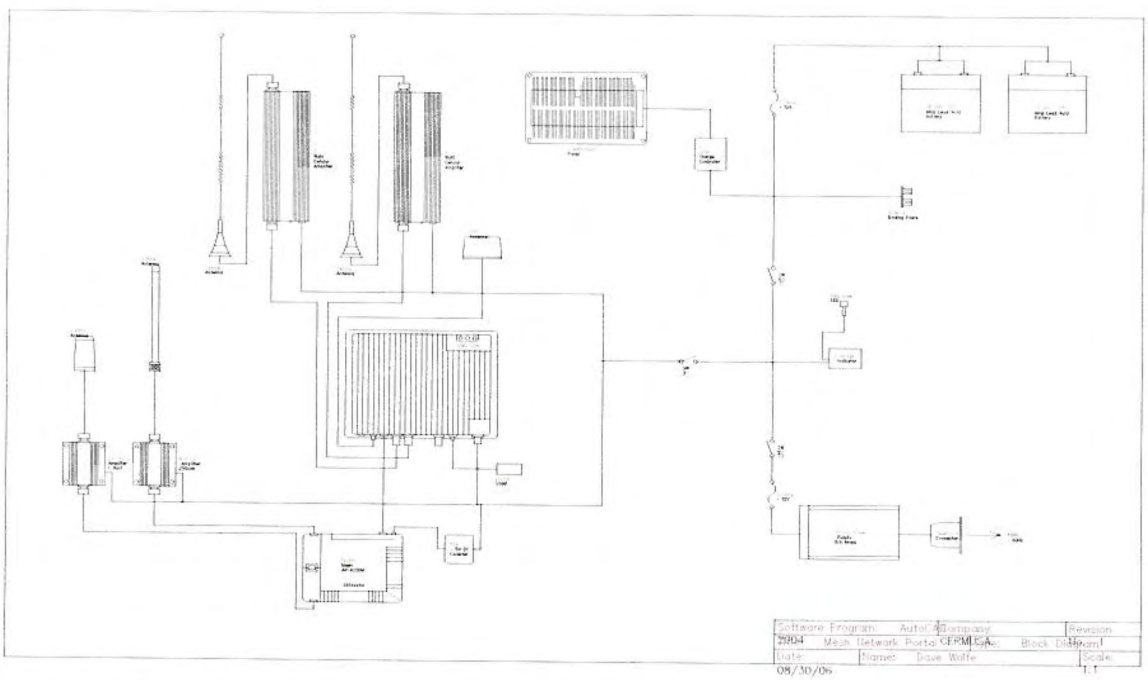
4. Antenex 2.4GHz 3dBi Phantom antenna.
5. Twist-Lock AC power connector.
6. 16/3 electrical cable – 6ft.
7. Pomona dual binding post.
8. B&B industrial panel-mount Ethernet jack.
9. PulseTech 2 Watt Solar Charging Panel.
10. Ault 12 Volt, 3.3Amp power supply.
11. PowerStream 20 Watt DC/DC converter.
12. Dual 12 Volt, 5.5Amp/Hour lead acid batteries.
13. PowerSonic battery charger.
14. BackOFF voltage indicator.
15. Red, Green, & Blue toggle switches.
16. Various RF cables and connectors, power cables and connectors, and heat-shrink tubing, etc.

6. Construct a prototype version of a ruggedized mesh access point.

- After most of the above equipment was purchased, CERMUSA technical staff built a prototype mesh box using an extra Pelican case. This exercise was performed to test fittings of all internal and external equipment. Masking tape and magic markers were used both in and outside the box to mark off where equipment should be mounted. No wiring or RF cabling was done inside this prototype as it was not deemed necessary for simple space considerations and would consume large amounts of time. Minor adjustments to the location of antenna mounts and the battery charger inside were needed after the prototype was constructed.
- CERMUSA technical staff disassembled the prototype box as most of the equipment inside was needed for actual mesh network box construction. A wiring schematic of the box was developed to be used for construction later. This schematic appeared as follows:



7. **Construct entire mesh network including a portal/gateway box.**
   - CERMUSA technical staff laid out all of our equipment on tables in a conference room downstairs at CERMUSA. Ten small mesh network boxes and one larger, portal/gateway box were to be built. Staff drilled holes in the Pelican cases and mounted all exterior equipment. Poly-Lock Velcro was cut to length and all internal equipment including the Proxim access points were mounted inside the boxes. CERMUSA staff then made RF interconnect cables and jumpers to connect the amplifiers and antennas to the access point pigtail connectors. All electrical wiring was soldered and covered with heat-shrink tubing to ensure quality, long-lasting connections.
   - In a similar fashion, a Mesh Network Portal/Gateway box was constructed. This unit is about twice the size of a normal mesh box in this system. The software in the Portal/Gateway box was programmed to control and monitor the mesh network as well as provide the Internet or LAN connection. It contained the same equipment as each mesh box with the addition of a cellular gateway and cellular amplifiers. An OMG-1000 Mobile Gateway and two 3-Watt SmoothTalker cellular amplifiers were installed in this box. The OMG-1000 can provide an Internet connection via either Verizon or Cingular cellular PCMCIA cards in the event a Local Area Network connection is not available for the mesh network. The potal/gateway box schematic appeared as follows:



   - Functional power-up and voltage measurement tests were performed at various test points within the boxes to ensure each piece of equipment was

getting the proper voltage and current required for operation. Everything passed the testing and worked according to specification.

8. Conduct field testing activities

- CERMUSA personnel conducted multiple indoor and outdoor tests of the mesh network boxes. Testing was done in extreme heat and cold, as well as damp and rainy conditions. Most of the testing maintained the portal/gateway box connected to CERMUSA's LAN or the Saint Francis University LAN for backhaul Internet and network connectivity. Mesh boxes were placed throughout the campus, in open fields, in buildings, on rooftops, and throughout dense woods and foliage for different tests. Standard test procedure involved gradually extending the network one mesh box at a time until all four hops in a given direction were exhausted. Streaming video, file download/transfer, videoconferencing, and ping tests were used as measures of overall network performance from multiple end points.
- Several different types of technology were tested over the mesh network. Streaming IP video from a web camera, two-way video teleconferences, wearable wireless video conference equipment, large file transfers, and two-way text messaging were a few types of tests performed.
- Each formal test and results were documented in detailed reports.
- Test 1: Field testing on Saint Francis University Nature Trail: CERMUSA technical staff used a series of mesh access points to reach several hundred yards within the Saint Francis University Nature Trail, a biological study area located near the CERMUSA offices. Using a series of four boxes, technical staff extended the CERMSUA LAN approximately 200 yards from the offices into the nature trail. Transmission tests included streaming video, ping tests, file downloads, and live videoconferencing using a wearable video unit. All applications showed near equivalency to traditional WLAN connections; the greatest challenge was finding the end of the transmission range (at distances of 100 yards between boxes in open areas, the units were still connecting). The excellent performance of each mesh unit actually hindered testing as technical staff began running out of physical testing area before losing coverage.
- Test 2: Field testing at Saint Francis football stadium: Technical staff repeated the nature trail test, but extended coverage from the CERMUSA John P. Murtha Building to the Saint Francis Football Stadium across campus, a total distance of 800 yards. Crossing this distance required a total of four access points, and yielded identical performance to the original Nature Trail test. Again, the chief difficulty experienced was measuring the efficacy of multiple points in the link "chain" as the signal strength of individual repeaters was often adequate to cross large distances.
- Test 3: Field testing at Saint Francis football game: Technical staff repeated the nature trail test during a Saint Francis football game to increase the chance of "real-world" variables (i.e. fans walking in front of repeater stations, inclement weather) interfering with the link. Despite component issues (the wearable VTC was unable to associate with multiple access points

automatically), the network showed no detectable degredation in performance from the original testing.

- Test 4: Field testing at Saint Francis football stadium (follow-up to game testing): Technical staff recorded similar results as the day of the actual game. This test is when technical staff realized the wearable VTC unit would only associate with one box unless rebooted. We did not create a formal report from this test as it was nearly identical and provided the same results as the actual game-day test.

9. Explore use of robotic/self-propelled access points

- Adding robotic platforms to the mesh network is another research objective of this project. CERMUSA would like to attach two of the mesh network boxes to self-propelled, remote-controlled robotic platforms to further extend the network into potentially dangerous, rough, or hazardous terrain.
- Research into suitable robotic platforms yielded several devices suitable for being modified to accomplish this task, however very few were found with controls that can be manipulated through an IP interface. Currently we are perusing a four wheel drive chassis from ActiveMedia Robotics. This unit would provide a fully controllable platform designed for extreme terrain and harsh weather environments. A mesh box can be mounted to the platform on this robot and connected to the Ethernet jack on the robot. Through a web interface, the robot can be driven and controlled through our mesh network from a remote location while extending and providing mesh services within range wherever it travels. This platform also includes the options for future upgrades including biosensors, sonar, and A.I. upgrades.
- CERMUSA technical staff is still in process of evaluating this option, based on limited end-of-year funding. The robotic chassis may be included in FY07 research spending if current funding is inadequate.

10. Revise access point/network design for improvement.

- This part of the process incorporated feedback from all previous steps. The results of this evaluation will be discussed in-depth in the following lessons learned section of the report.

Conclusions/Discussions/Lessons Learned:

After thoroughly testing the mesh network, CERMUSA found a few areas for improvement.

Range of the Proxim AP-4000M access point is limited to 4 wireless hops in any direction from the portal/gateway box.

Even though 4 hops allows a great deal of range using amplified 802.11a/b/g, we would like to find a different mesh access point that will extend the range to 10-12 hops in any direction.

The Proxim AP-4000M access point uses a single radio on 802.11a for backhaul network traffic between boxes. Clients connect using 802.11b/g. The limitation of using a single radio for backhaul purposes is that every box must be on the same channel and network traffic must traverse the links one at a time. As a result, full-duplex traffic is not possible. Inherently, this

limitation cuts available bandwidth approximately in half for each hop extended further from the portal/gateway box. For example, starting with an available bandwidth of 10Mbps at the portal/gateway, by the fourth hop that usable bandwidth will be down to about 1,250kbps, not including the overhead associated with the mesh architecture.

Although this bandwidth is somewhat limited, it is adequate for most applications. However, with increased users and applications on the mesh it could become a problem. New mesh network products are available now which contain three radios per box, two for backhaul, and one for client connection. A two-radio backhaul connection virtually eliminates the bottlenecking associated with a single radio approach. Little or no bandwidth is lost throughout the mesh no matter how far the node is located from the portal/gateway.

The results, can be applied to the original hypothesis as follows:

- *Rapidly-deployable, self-healing networks (Mesh) can be created from commercial-off-the-shelf components and be deployed in outdoor environments.*
  CERMUSA technical staff believes that we have positively proven this hypothesis. Our testing has verified that COTS-based components can be combined into outdoor-capable mesh networks.

  These networks will have a small form factor and be useful in tactical settings.
  Again, CERMUSA technical staff has proven that small factor (13.5" x 12" x 8" and approximately 19.2lbs) can be produced and that these devices are useful for tactical applications, such as surveillance or in any situation requiring a rapidly-deployable network.

  COTS-based robotic or remote control platforms will be useful in extending the reach of these networks.
  CERMUSA technical staff did not complete this part of the research, but hopes to continue investigating this concept in future research.

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Extensions/Stretch Goals:
CERMUSA's initial foray into mesh networking is already serving other operational (and potentially research) functions within the organization. The mesh boxes developed within the Wireless Testbed have already been deployed for a number of demonstration and operational projects, most notably to extend CERMUSA network access into areas lacking WLAN coverage. Additionally, CERMUSA is exploring the use of mesh networks to tie into the Mobile Communication Platform (MCP) Hummer vehicle to create "connected perimeters" in areas of operation. A mesh network could support any number of IP-addressable applications, including wearable videoconferencing and chemical/biological sensors, for reachback capabilities in an area of operations.

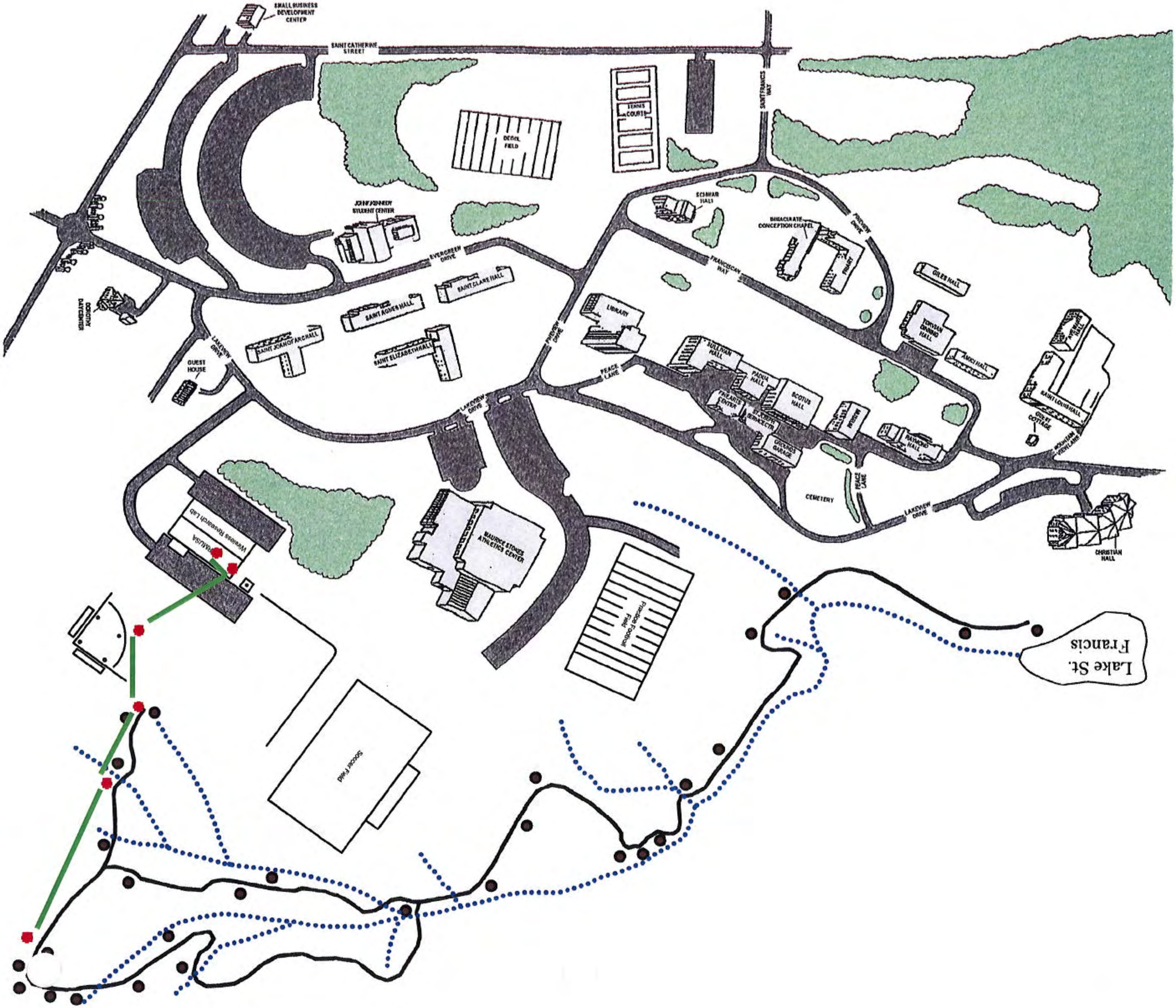
CERMUSA also hopes to expand this established work through experimenting with robotic/self-propelled access points. Combined with future revisions of the mesh devices to expand the total number of hops available, a motorized (and potential automatically-deployed) robot system could canvas a given area of operations with wireless coverage with little manual intervention. Such architectures could be used in a variety of tactical environments to support data transmission and exchange from any number of IP-capable devices, including robots such as unmanned aerial vehicles. Additionally, remote controllable devices could be used to extend these services and monitoring capabilities into hazardous areas without putting human users in danger.

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 001 – Notes

08/22/06 – Tuesday

- CERMUSA technical staff tested the mesh network outside the WRL, on the SFU campus. OMG box was set up the in Officule H. Next to it we connected a mesh box with the IP camera connected to it viewing a constantly moving screen saver on a laptop. Staff placed one box at each at the following locations: in the middle of the softball field; beyond the field at the entrance to the Nature Trail; about 65 yards into the Nature Trail; and about 130 yards into the Nature Trail; four boxes plus the gateway. Throughput averaged ~300kbps download tests from PC Pitstop, viewing the IP camera in the WRL at 384kbps, and staff was able to make successful Frontline Communicator calls into the lab computer at around 200-400kbps. The Frontline Communicator calls dropped a few times. The mesh was functioning at this point through the maximum of four successive hops. At this level, the mesh network worked as expected in terms of the data output and latency.



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TENNIS COURTS
DEGEL FIELD
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SCHWAB HALL
IMMACULATE CONCEPTION CHAPEL
FRIARY
FAIRVIEW DRIVE
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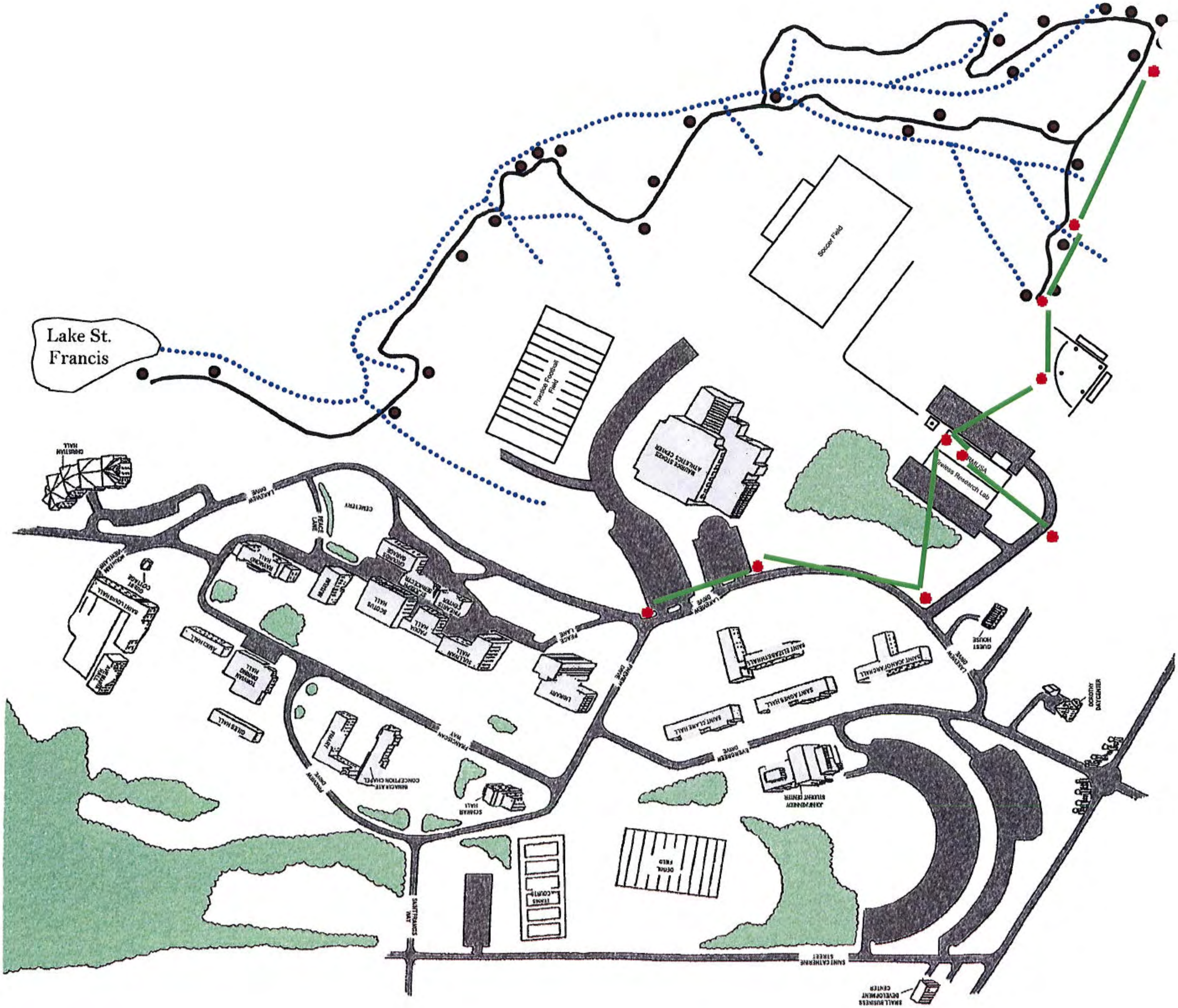
TORVIAN DINING HALL
ANTHONY HALL
SAINT LOUIS HALL
FRIARS CENTER
GROUNDS GARAGE
RAYMOND HALL
GUEST COTTAGE
CEMETERY
Wireless Research Lab
RMUSA
MAURICE STOKES ATHLETICS CENTER
Practice Football Field
Soccer Field
CHRISTIAN HALL
Lake St. Francis

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 002 – Notes

08/22/06 – Tuesday

- Our second test of the day required adding four additional mesh boxes. Technical staff placed mesh boxes as follows: one by the fire hydrant halfway out Peace Lane, one near the power box at the intersection of Peace Lane and Lakeview Drive, one at the end of the parking lot on the hill of Lakeview Drive, and one at the corner of the lower Stokes parking lot and Lakeview Drive. The boxes ended up meshing through the box next to the onboard mobile gateway (OMG), then out through the three on Lakeview Drive. The box next to the fire hydrant was skipped from the chain. Again, technical staff achieved four hops and performed successful ping tests and internet downloads from PC Pitstop. Staff then tried the Frontline Communicator again. The Frontline connected from the fourth mesh box. Calls at 200kbps were achieved, however, they dropped every few minutes. Technical staff wearing the Frontline walked up the hill towards the other mesh boxes in the chain. The calls seemed to get more reliable as the Fontline was positioned closer to the OMG box and was transferring streaming video through fewer hops. At the top of the hill through two hops 600kbps video transmission from the Frontline was stable. Technical staff were pleased with this result. Both links of four mesh hops, both down Lakeview Drive and out to the Nature Trail, were up and functional simultaneously.

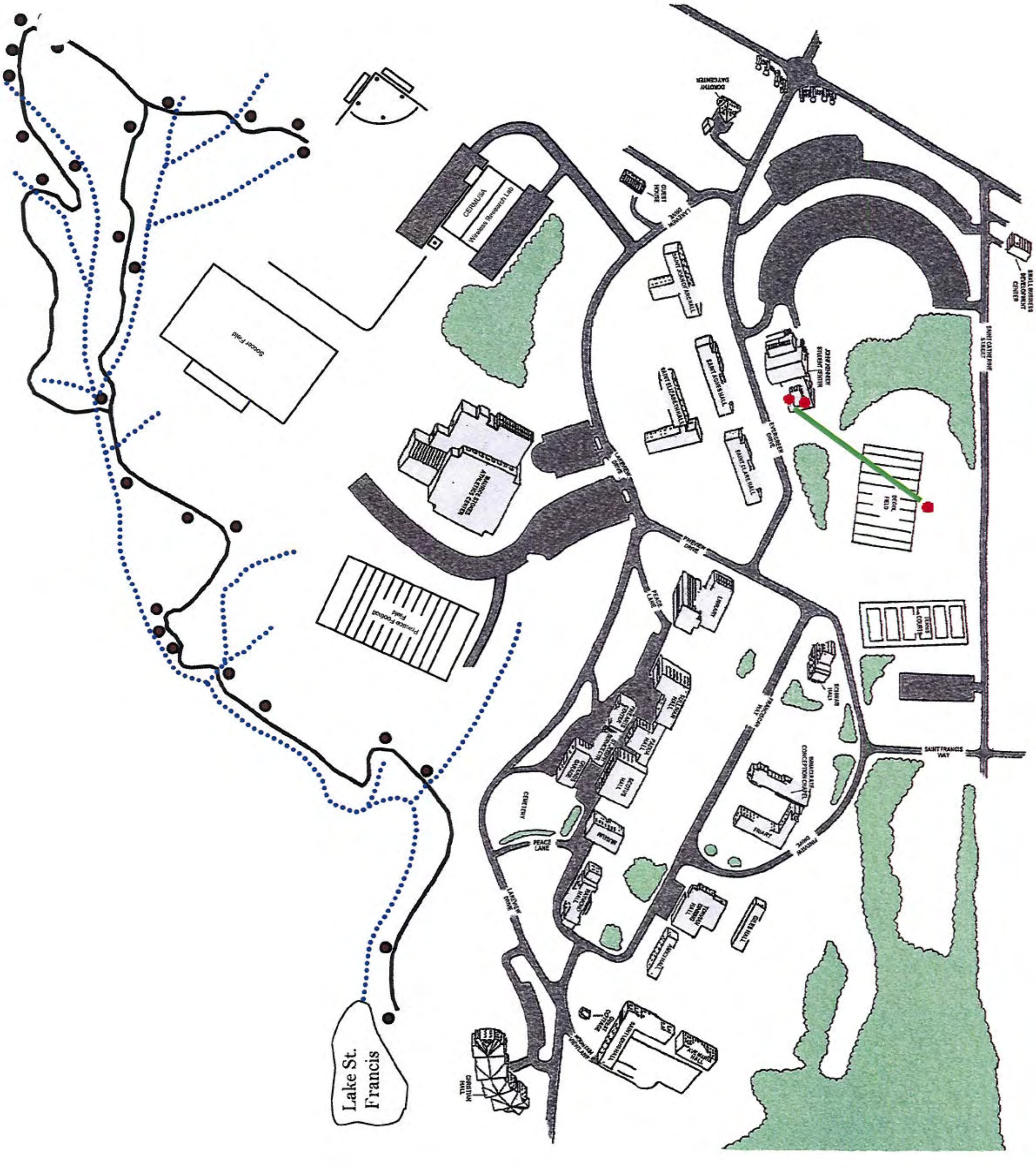

Lake St. Francis
Soccer Field
Practice Football Field
RMUSA
Wireless Research Lab
Maurice Stokes Athletics Center
Lakeview Drive
Guest House
Dorothy Daycenter
Saint John of Arc Hall
Saint Elizabeth Hall
Saint Agnes Hall
Saint Clare Hall
Evergreen Drive
John F. Kennedy Student Center
Saint Catherine Street
Small Business Development Center
Library
Peace Lane
Cemetery
Scotus Hall
Sullivan Hall
Franciscan Way
Schwab Hall
Immaculate Conception Chapel
Friary
Tennis Courts
Saint Francis Way
Giles Hall
Christian Hall

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 003 – Notes

08/24/06 – Thursday

- Technical staff performed a streaming video test with the mesh boxes from the JFK Student Center to the football field. The OMG box was set up in the upper lounge of JFK and connected it to the SFU network with a Cat-5 cable. A Mesh Network box was set up next to the window facing the field; a link was verified between this mesh box the OMG unit. Another box was positioned in the press box above the field on the far side. It linked to the OMG box without going through the box near the window, making this a single hop test. PC Pitstop tests averaged about 2Mbps from the internet. A laptop with a USB camera was set up to stream video back to a server at CERMUSA through the mesh network and SFU's LAN. The connection was fairly stable. Technical staff was able to view the stream on the CF-29 linked wirelessly to the mesh box in the press box at around 500kbps. Video connections froze several times to buffer the video, but video staff indicated that such stream interruptions are common even on wired networks. 200kbps download speeds from the internet while streaming the video.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Wireless Research Lab
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Practice Football Field
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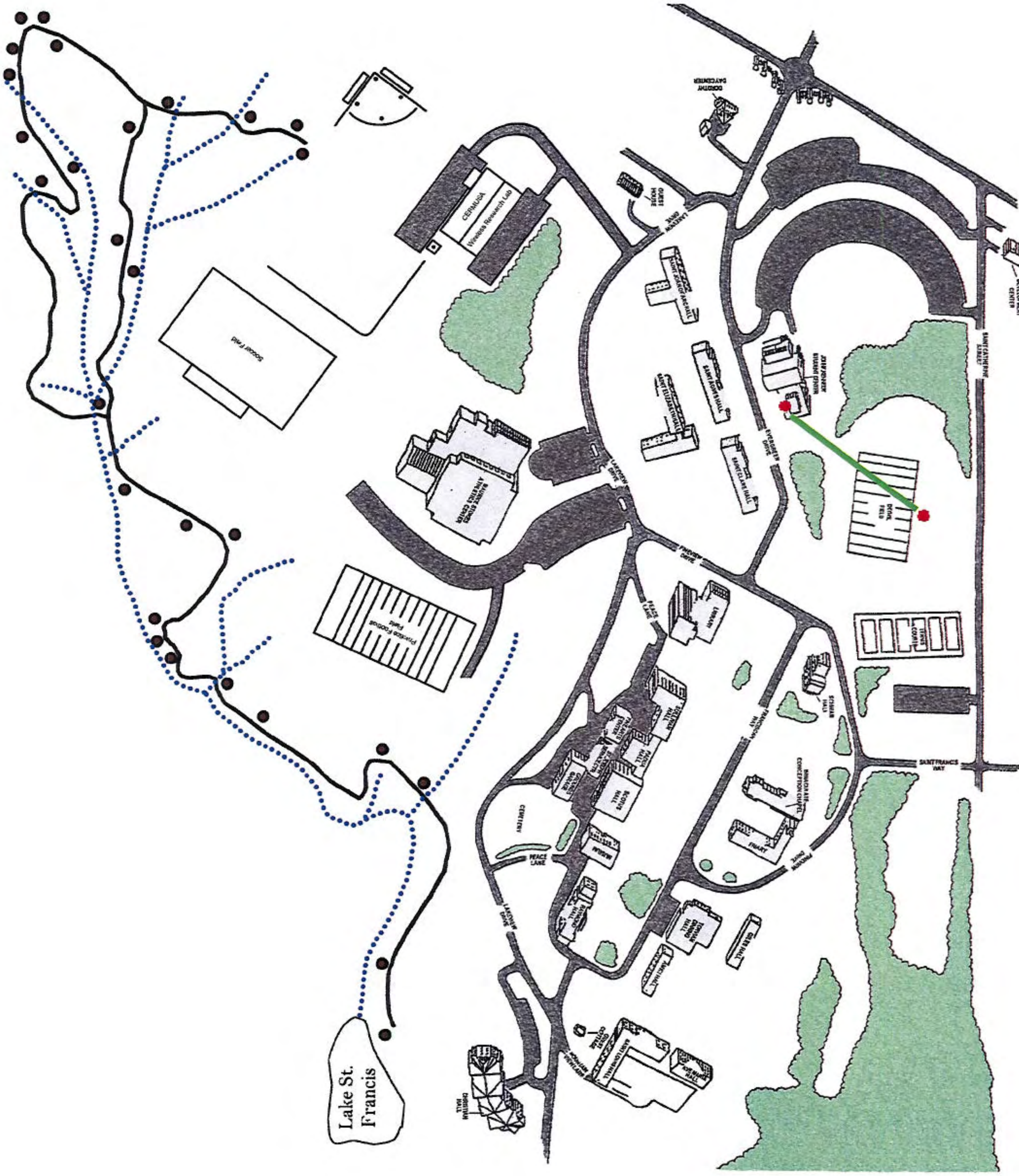
LIBRARY
TENNIS COURTS
SAINT FRANCIS WAY
SAINT CATHERINE STREET

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 004 – Notes

08/29/06 – Tuesday

- Technical staff set up the mesh Portal box in the JFK lounge and a mesh node box in the press box at Degol Field and tested the streaming video again. The video worked very well this time. Saint Francis ended up getting the fiber connection punched down in the press box so the mesh wireless solution would not be deployed for a weekend football game (we had anticipating testing our system by streaming a live game). The mesh boxes were removed and returned to CERMUSA.

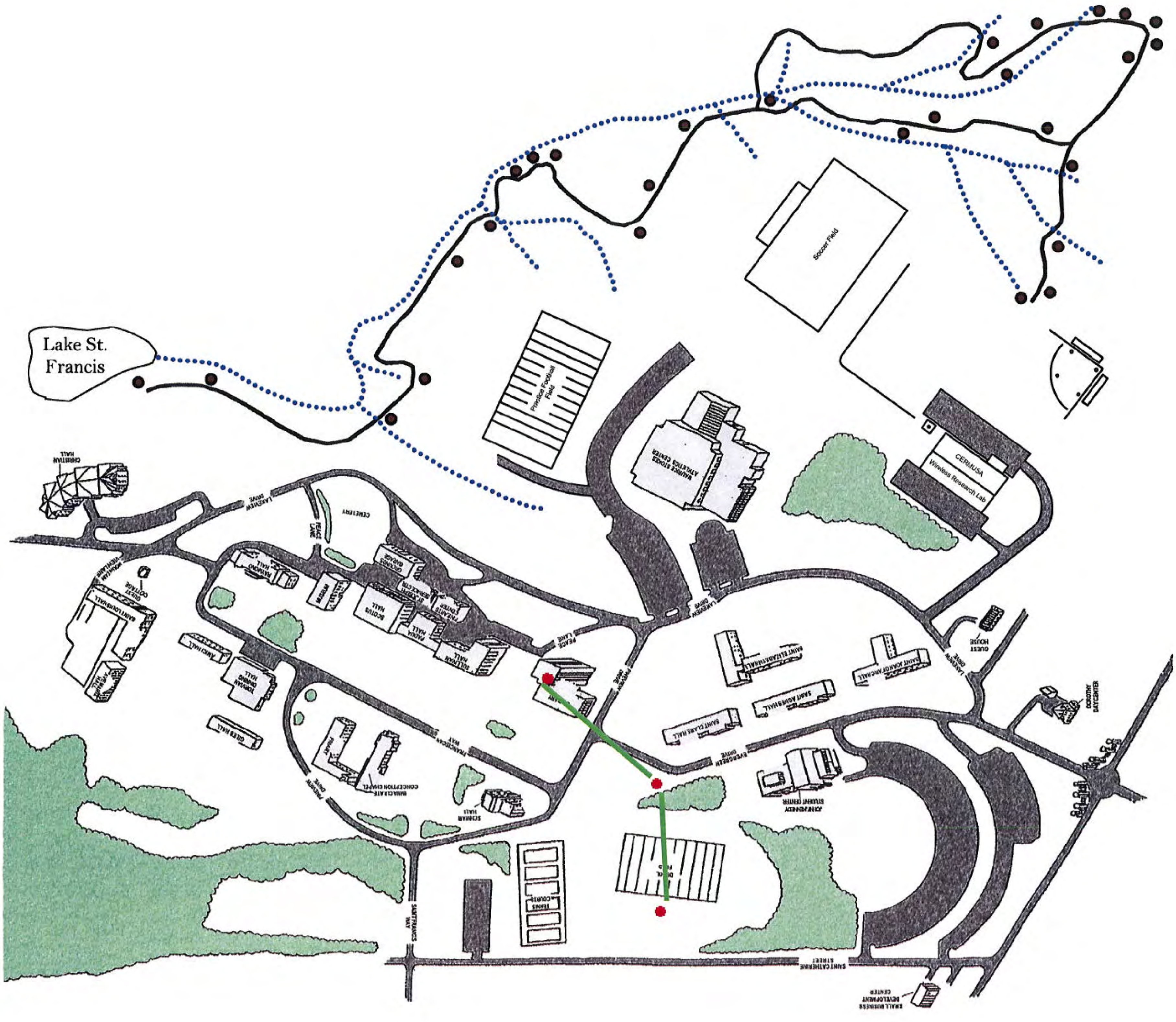

Lake St. Francis
Wireless Research Lab

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 005 – Notes

08/31/06 – Thursday

- Technical staff performed additional mesh network testing around campus. The OMG was set up in Officule H of the wireless research lab (WRL) and connected to CERMUSA's LAN with a Cat-5 cable. Another mesh network box was placed at the end of the WRL lane, down over the hill by the entrance to the upper JFK parking lot, and at the far end of the upper JFK parking lot. Successful ping tests were performed from all locations to the internet. Technical staff also ran average bandwidth testing from each node back to the internet and file transfers from each node back to a computer on CERMUSA's LAN. Through one hop speeds averaged 4166kbps download from PC Pitstop and around 4-7Mbps file transfer between two laptops using NetPerSec to monitor the bandwidth. Through two hops speeds averaged 1542kbps download from PC Pitstop and around 1.5-3Mbps file transfer between two laptops using NetPerSec to monitor the bandwidth. Through three hops speeds averaged 495kbps download from PC Pitstop and around 2-3Mbps file transfer between two laptops using NetPerSec to monitor the bandwidth. There was at least 100 yards of distance between each hop. Additionally, several of the hops did not have line-of-site. The mesh network boxes performed very well in this test.



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TENNIS COURTS
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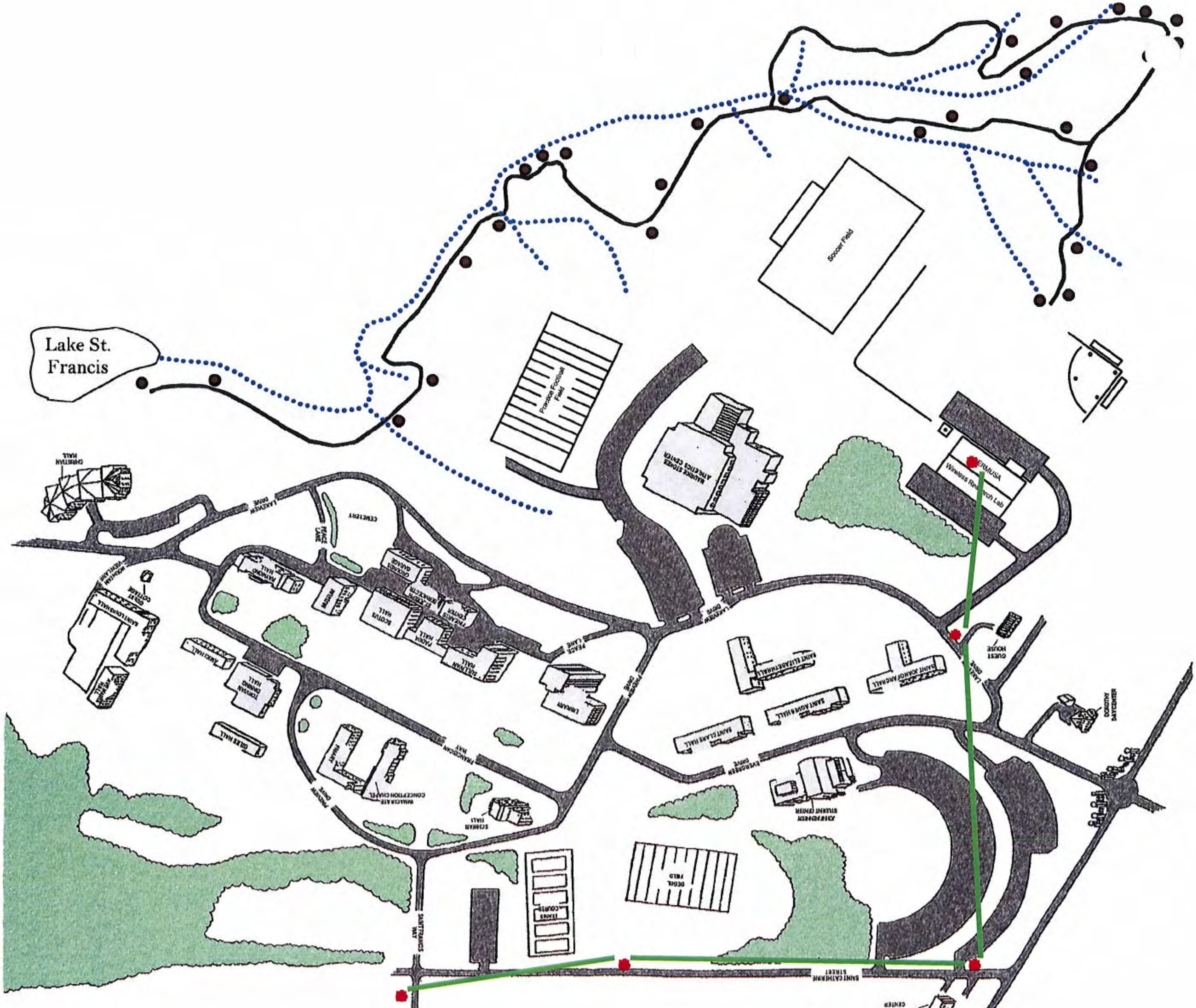
SMALL BUSINESS DEVELOPMENT CENTER

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 006 – Notes

08/31/06 – Thursday

- Technical staff tested another route through campus with the mesh network boxes. The OMG was set up in Officule H of the WRL connected to CERMUSA's LAN with a Cat-5 cable. A mesh network boxes were dropped at the end of the WRL lane, at the far end of the upper JFK parking lot, at the entrance to Degol Field and the SFU Track Complex, and on the corner steps at the East Gate Hall; there were at least 100 yards of distance between each hop, with some locations lacking line of site. Successful ping tests were performed from all locations to the internet. We also ran average bandwidth testing from each node back to the internet and file transfers from each node back to a computer on CERMUSA's LAN. Through one hop, speeds averaged 4166kbps download from PC Pitstop and around 4-7Mbps file transfer between two laptops using NetPerSec to monitor the bandwidth. Through two hops speeds averaged 1542kbps download from PC Pitstop and around 1.5-3Mbps file transfer between two laptops using NetPerSec to monitor the bandwidth. Through three hops speeds averaged 495kbps download from PC Pitstop and around 2-3Mbps file transfer between two laptops using NetPerSec to monitor the bandwidth. Through four hops speeds averaged 406kbps download speeds from PC Pitstop and around 500kbps file transfer speeds between two laptops using NetPerSec to monitor the bandwidth. Despite a lack of reliability in file transfer, CERMUSA technical staff determined was that the mesh network boxes performed very well in this test.



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Saint Elizabeth Hall
Maurice Stokes Athletics Center
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Padua Hall
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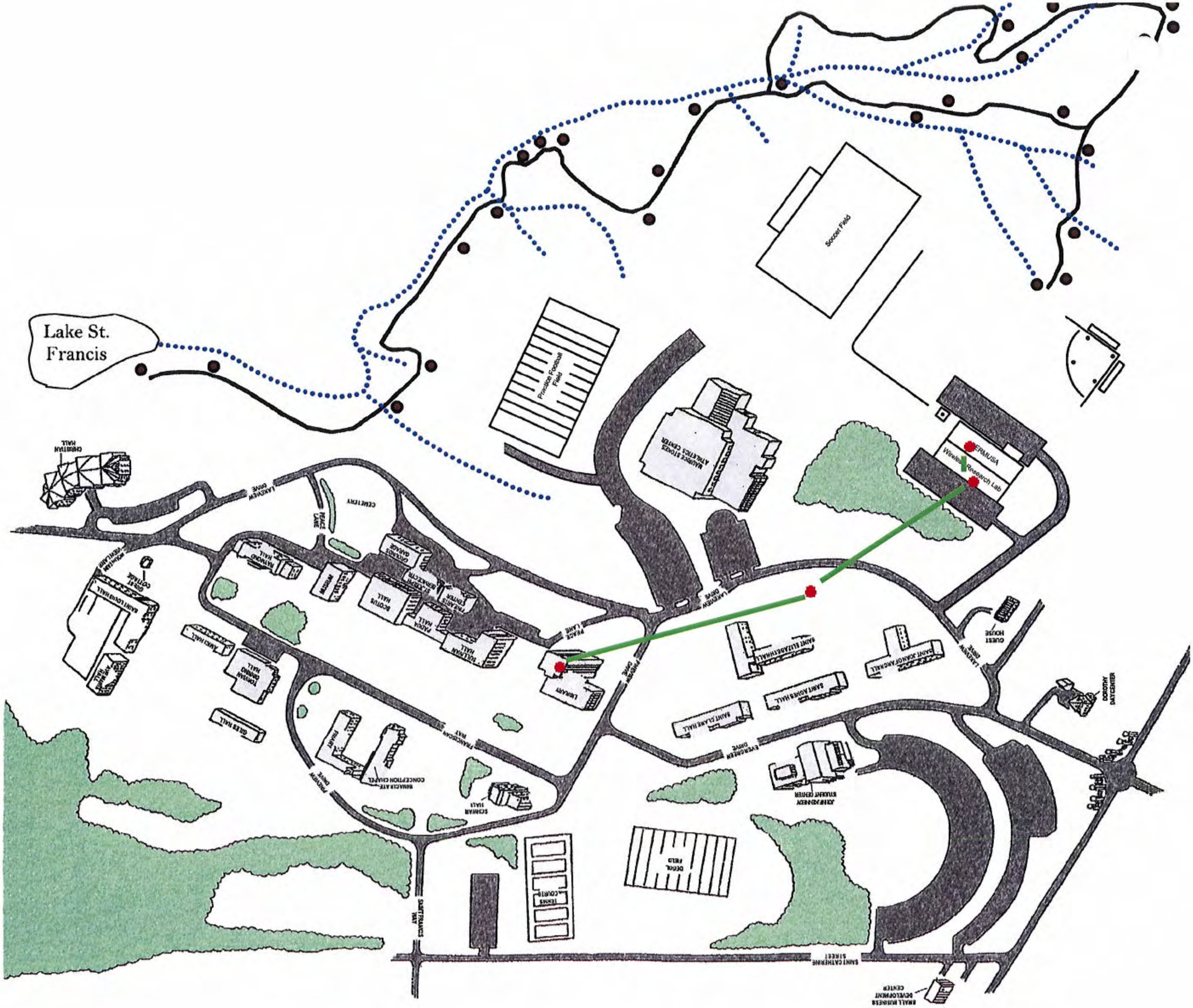
Sullivan Hall
Christian Hall

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 007 – Notes

08/31/06 – Thursday

- Technical staff tested a route from the WRL to the Library on campus with the mesh network boxes. The OMG was set up in Officule H of the WRL connected to CERMUSA's LAN with a Cat-5 cable. A mesh networking box was placed in the window of the conference room upstairs, a box in the grass outside the dorms along Lakeview Drive, and a box on the corner of the Library roof. Ping tests were achieved with internet addresses from as far away as the Library roof. Average bandwidth testing from PC Pitstop was about 2090kbps and file transfer speeds between two laptops monitoring with NetPerSec was about 1.8Mbps. Technical staff tested the transmission limits of the mesh boxes by attempting to link from the WRL to the Library in a single hop, but were unsuccessful. With two hops though, the mesh network boxes performed very well in this test.



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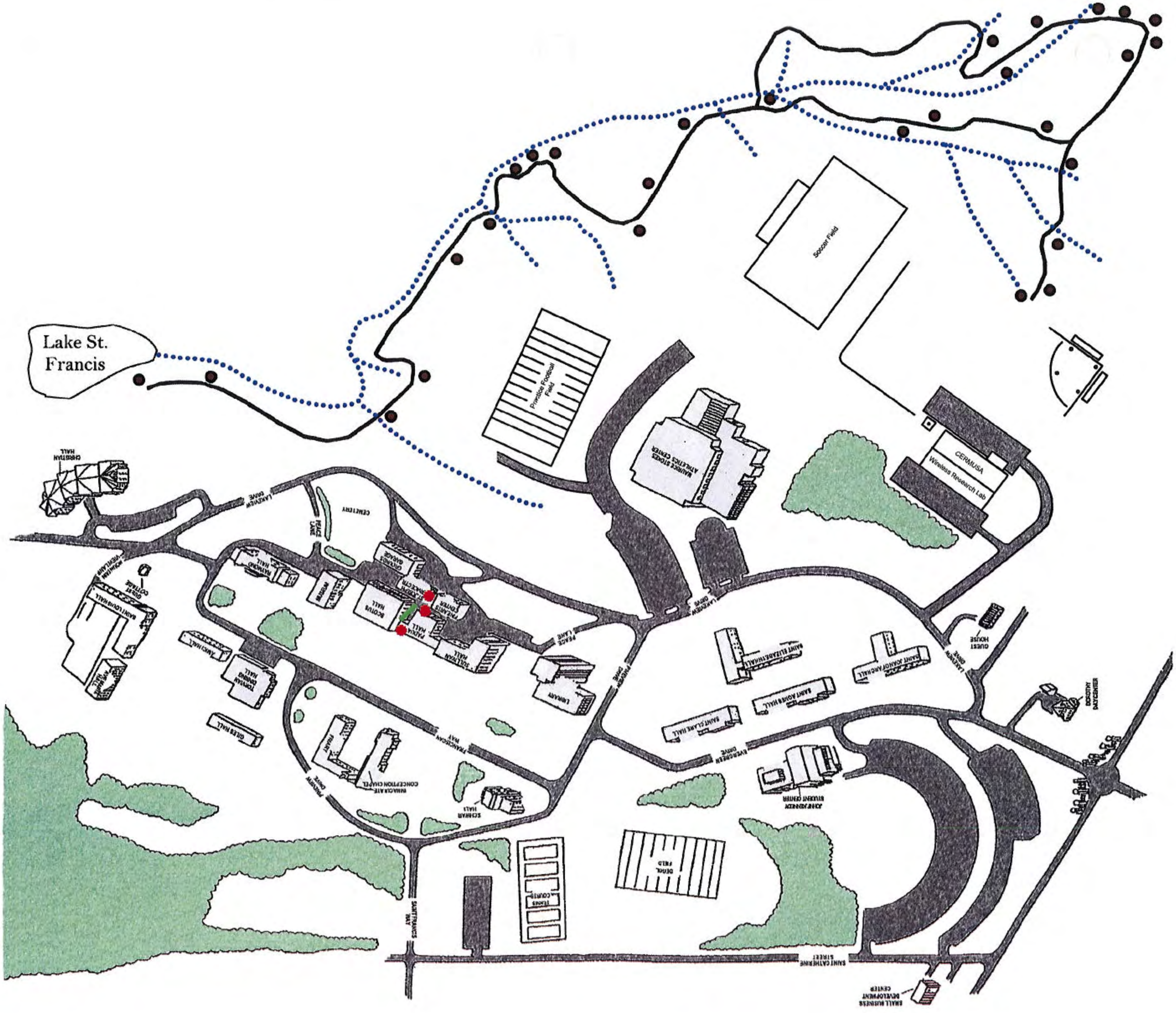
Immaculate Conception Chapel
Schwab Hall
Tennis Courts
Saint Catherine Street
Saint Francis Way
Giles Hall
Saint Louis Hall
Christian Hall
Sullivan Hall
Padua Hall
Scotus Hall
Grounds Garage
Raymond Hall
Small Business Development Center

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 008 – Notes

09/07/06 – Thursday

- CERMUSA technical staff tested the mesh network from the DLPL in Padua to the Boiler House on campus. The OMG was set up in the DLPL and connected to CERMUSA's LAN with a Cat-5 cable. The first mesh network box was set up off the side of the road near the steps between Padua and the Boiler House. The second box was set up inside the Boiler House on one of the window sills near an electrical outlet. It took two hops to go this short distance due to the severely thick and reinforced concrete and brick walls of these buildings. 1.5Mbps download speeds from PC Pitstop were achieved. Technical staff also tested the Polycom PVX VTC software and a web cam connected to a CF-29 Toughbook. 384kbps calls to JC Blair functioned well, with acceptable video quality. 512kbps calls looked acceptable also. 768kbps calls were unsatisfactory, with broken audio and video tiling. Overall network latency acceptable with camera controls at 512kbps . NetPerSec measured about 250kbps upload and download speeds simultaneously for the 384kbps call and 450kbps speeds for the 512kbps call.



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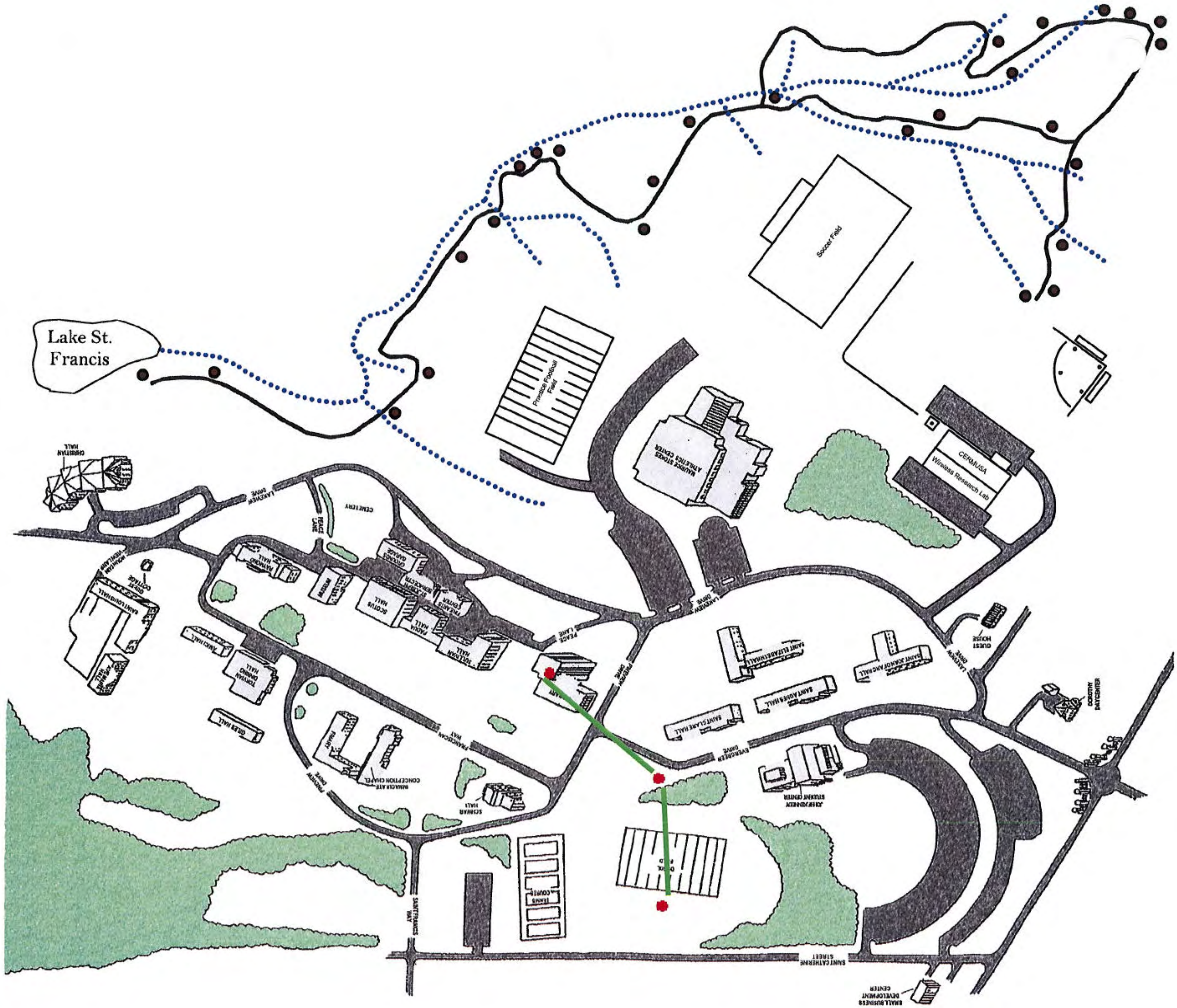
GILES HALL
GUEST COTTAGE

CERMUSA Mesh Network Testing Information

Mesh Network Testing – Official Test 009 – Notes

10/28/06 – Saturday

- Technical staff tested the mesh network and Frontline Communicator at the Saint Francis University football game today. The OMG was set up on the roof of the Library and linked directly to CERMUSA's LAN. A mesh network box was placed between the Library and the Press Box and a node was placed on the roof of the Press Box. A two-hop mesh network was formed. One member of technical walked around the football field and through the stands wearing the Frontline Communicator while a second staff member remained at the WRL and monitored the streaming video and audio from the Frontline on a computer in the lab. Average transmission rates were about 200-300kbps. At times the rates jumped to 600-700kbps and fell to 9kbps. Rate fluctuation was relative to the location of the Frontline in proximity to the mesh boxes providing wireless access to the field. Handoff from box to box was not seamless. Video rates varied widely as we walked to different locations. Receive video quality from the Frontline was acceptable and the device performed well for having a small embedded 802.11b transmitter and antenna. Future plans include adding a few more mesh nodes to the field and modifying the Frontline with an external antenna and 802.11 amplifier.



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TENNIS COURTS

FREC-M

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: First Responder Emergency Communications—Mobile (FREC-M)

Protocol No.: **05-TATTH207-05**

Date: February 2, 2007

Protocol Title: First Responder Emergency Communications—Mobile (FREC-M)

Primary Investigator(s): Vicki Pendleton, RN, BSN, MMS

Abstract:
Much of Pennsylvania's rural population is located great distances from healthcare and communication infrastructure making it difficult for the first responder to communicate with physicians during patient transport. Increasing the level of communications will have a dramatic effect on the quality of care for the emergent patient.

The Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) has designed and deployed an ambulance to Cresson Area Ambulance, equipped for the 21st century with state-of-the-art communication devices for the patient and the providers. This vehicle provides interactive audio, video, and data transmission capabilities providing paramedics and medical command physicians the latest up-to-date vital signs, twelve-lead electrocardiogram (ECG) tracings, real-time pictures of the scene and images enroute to the hospital, This technology permits the physician to observe patients and anticipate difficulties that may be encountered during patient transport. Digital data transmission (text messaging, ECG, vital signs) and audio communications during patient transport without interruption has been accomplished through the use of this new technology to Memorial Medical Center in Johnstown and Altoona Regional Health System in Altoona.

Introduction/Background:
Pennsylvania, like many other parts of the United States, is home to vast expanses of sparsely populated areas. As a result, wireless communication service in these areas varies from passable to non-existent. Emergency services providers are often hindered in their efforts based on "dead spots" where radio or cell phone connectivity is impossible. These rural areas are located great distances from advanced medical care and hospitals, especially the tertiary care centers that provide sophisticated, emergent and specialty care. The remote location of these populations, weather, and geography, create problems within the realm of emergency medical care and treatment due to the inconsistent or lack of communication capabilities. The environmental surroundings within these remote areas create many unique challenges for the prehospital healthcare provider (Woollard, 1999). There are many areas where transmission and retrieval of several wireless signals is difficult which more commonly are due to the lack of radio, cellular, and repeater towers. The lack of this supportive infrastructure further complicates the problem of the wireless signal transmission (Mellot, 2002). Although first responders are often well trained, many situations involve injuries that require a higher level of care. It is often difficult for the first responder to establish, maintain and document continuous communications during patient transport. Communications can often make the difference between life and death of the critically ill or injured patient (Gandsas, et. al, 2000). The solution has been determined to be adequate and appropriate wireless communications from the scene and or ambulance to the receiving facility where highly trained healthcare providers are located.

There are several different mobile Emergency Medical Services throughout the United States, each using different types of technology and bandwidth (Caputo, 2003; Salinas, 2002; Levine, 1999; Ricci, 2002). Each program is striving to meet a specific need in their community. All of these programs are being developed to bring high quality care to the prehospital patient. The applications of all these protocols may still create instances of inaccurate or corrupted clinical

data, which is unacceptable in critical care. Through the completed testing, CERMUSA identified and solved as many potential problems as possible prior to the deployment of this prototype. James Effinger, NREMT-P, Paramedic Manager of the Cresson Area Ambulance Inc. initially will randomly select daylight trauma and medical transports that are being transported to Memorial Medical Center in Johnstown and Altoona Regional Health System in Altoona, PA. Once the paramedic staff becomes comfortable with the communications equipment, the study can be done on a 24-7 basis. This study will involve use of the Ortivus monitoring system and digital radios or amplified cellular systems for data transmission and audio contact with the emergency department by the paramedic. There will be no difference in the care of the patient, only use of diverse communication systems by the paramedic. If the medical command physician wants to view the on-board video, the video-teleconference connection will be made to the Emergency Department through satellite connections from the ambulance.

This technology is designed primarily for the transmission of patient information such as vital signs, ECG, and pulse oximetry. Throughout this study, CERMUSA continues to identify technology that is necessary to transmit continuous audio, video, and medical information to the hospital during emergency situations. The ambulance has been equipped with radios, cellular phones, and satellite technologies proficient in sending digital and video data to a receiving facility. Preliminary testing of this protocol shows that this is the appropriate approach to beginning the resolution of communication difficulties faced by the prehospital healthcare providers in Western Pennsylvania.

An organized test plan was implemented in the designated five-mile test bed around Saint Francis University. Ten locations were picked as random test points. A laptop equipped with Ortivus software, a screen capture utility and professional quality printer was set up in the ambulance along with all Mobimed equipment to measure twelve-lead ECG, blood pressure, and pulse oximetry on a live person. A travel route was planned and exact printouts of the live vital signs were taken in the ambulance at each test point. Several locations were tested while moving and the remaining samples were taken at stationary positions. After successful transmission at all sites, CERMUSA personnel returned to the office to compile and compare data. The time frame from each of the ten sites was reviewed and printed on the hospital workstation laptop at CERMUSA.

Further testing was accomplished in the five-mile test bed (with 64 sites utilized) for data and voice transmission. At this time, the results obtained from both testing periods have concluded that the data transport system (Motorola ASTRO radio system) is performing at its designed parameters during the testing conducted in the designated five-mile test bed area.

Comparison of transmitted ECG signals included the PR interval, QT interval, and the R-R interval (in all three testing scenarios) revealed no discernable differences from the ambulance setting to the hospital emergency department. Therefore, CERMUSA personnel have determined that accurate, real-time data and vital sign transmissions through the Ortivus software are possible over the Motorola ASTRO radio system from a moving platform in the expanded test bed.

Hypothesis:
Advanced wireless communications through a mobile platform will provide a higher level of care for the critically ill or injured patient through continuous communication with medical command physicians and the hospital during patient transport to the tertiary care center.

Methods and Materials:
Technology within the FREC-M includes Very High Frequency (VHF), Ultra High Frequency (UHF) digital and VHF and UHF and low band analog radios, Tuff Book Panasonic computer with Ortivus Software for digital radio audio and data transmission (voice, vital signs and text messaging), INMARSAT Satellite technology with LED monitor, 2 cameras in the back of the ambulance facing the patient and paramedic, one overhead camera (over the patient) capable of panning and zooming for physician access to patient appearance. An outside camera on the cab of the vehicle allows visualization of the scene with a 300 degree circumference with panning and zooming capabilities. This permits the paramedic to show the receiving hospital the scene and mechanism of injury of the patient prior to extrication and transport.

On arrival at scene, the paramedic will take the laptop and Blue tooth monitoring apparatus to the patient (if appropriate) and place it on the patient. If the encounter is a scene run involving a trauma patient and medical command or the paramedic feels it is appropriate to send video of the scene to the hospital and this can be accomplished without compromising the care of the patient, the video connection can be established and the outside camera on the ambulance will be used to send back real time video from the scene to the tertiary care center. The patient will be transferred to the ambulance on a secured litter and locked down on the ambulance floor as per Emergency Medical Services (EMS) protocol. The Blue tooth monitoring system will send the data to the laptop in the ambulance and the communication connection will be made to the hospital with the appropriate communications device, amplified cellular for Altoona and cellular or digital radio for Johnstown. Data (twelve-lead electrocardiogram, blood pressure, heart rate and pulse oximetry) will be transmitted to the hospital as soon as the communication connection is established. The paramedic will make the initial audio connection to the hospital emergency department alerting the staff that data is forth coming into the laptop located in the medical command room. As per EMS protocol, the paramedic will give an initial report to medical command and receive any orders. If the medical command physician wishes to see the patient, the video connection will be made to the hospital through satellite technology by the paramedic. The video connection will be maintained long enough for the physician to make his or her assessment and then the connection will be discontinued. However, audio and data connection will be continued until arrival at the hospital, the patient is delivered to the emergency staff and report is given at bedside. The current twelve lead ECG and any other ECGs which the physician may find relevant and vital signs, will be printed on the available printer on the communication cart in the medical command room and placed on the patient's chart. CERMUSA will use the results of these evaluations to determine if the subjects felt the study equipment (technology) improved the communications during patient transport.

After each transport, using the study equipment, the staff (ambulance and emergency department) will complete evaluation forms. These forms will be collected by the PI at the end of each month. They will be securely stored at the hospital and ambulance station before collection.

Key Research Accomplishments:

- CERMUSA has demonstrated, through testing, that the FREC-M is capable of providing continuous communications between the prehospital providers and the emergency room physician throughout emergent transport.
- CERMUSA has demonstrated, through testing, the ability to transport information of clinical relevance safely and accurately to a medical command physician.
- CERMUSA has demonstrated, through testing, the ability to transmit information of clinical relevance reliably by comparing the information sent with the information received.
- CERMUSA has demonstrated, through testing, the capacity to provide a method of transmitting / receiving information that can be successfully integrated with the competing workload demands in the hospital setting.

Reportable Outcomes/Research Results:

Further testing was accomplished in the five-mile test bed (with 64 sites utilized) for data and voice transmission. At this time, the results obtained from both testing periods have concluded that the data transport system (Motorola ASTRO radio system) is performing at its designed parameters during the testing conducted in the designated five-mile test bed area.

Comparison of transmitted ECG signals included the PR interval, QT interval, and the R-R interval (in all three testing scenarios) revealed no discernable differences from the ambulance setting to the hospital emergency department. Therefore, CERMUSA personnel have determined that accurate, real-time data and vital sign transmissions through the Ortivus software are possible over the Motorola ASTRO radio system from a moving platform in the expanded test bed.

Conclusions/Discussions/Lessons Learned:

It has been concluded that the results obtained by the initial testing has provided the statistical and diagnostic evidence of proper and full system operation performance to the extent required by the medical personnel that would be using the system for diagnostic purposes. The Motorola, ASTRO radio system is performing at its designed parameters with the testing mainly conducted in the designed coverage area by CERMUSA personnel.

The FREC-M is state of the art with safety features (five-point restraints for paramedics reinforced walls and secured equipment). CERMUSA is now able to provide audio, video, data, cell phone, and Internet connectivity that will allow the prehospital healthcare provider to administer the highest quality, most-appropriate and supervised care patients can received in this area. This superior, technological ambulance will allow those in the field, domestic or military, peace or wartime, to maintain contact with and under the supervision of a physician. Testing of the communication and treatment technology in this primary prototype vehicle will be completed with paramedics, medical command physicians and the staff of the emergency departments throughout the SAEMS area. This will allow further evaluation of this technology and specific adjustment of the system before the actual full prototype vehicle is placed into the emergency medical system for actual patient care.

The FREC-M was deployed to the Cresson Area Ambulance prior to implementation of the research protocol. This decision was made allowing paramedics to complete preliminary technology field testing and become familiar with the technology before inception of the study.

It was found that the computer program being used was not user friendly, especially to individuals who had only a rudimentary knowledge of computer technology. Technical glitches also occurred in the hospital emergency departments with computers shutting down and not receiving the data being transmitted. Due to the delays in implementing this program, the technology has become outdated. New data transmission technology is available at less cost, is more user friendly, and provides better technology for patient data transmission. Much of this technology is aligned with the current Life Pak 12 currently in use by many of the ambulance services in the SAEMS. There also has been difficulty with the INMARSAT system in connection and strength of the signal for video transmission. This became apparent during the testing process with the prehospital providers. It has become apparent that there are too many steps for the paramedic to accomplish with the computer and the satellite access while attempting to care for the patient.

Our world is becoming consistently more dependent upon technology. Technology and methodologies are being updated on an almost daily basis. When first starting to design this project, the Ortivus system and the Motorola ASTRO Digital Radio System were the only technologies available to accomplish CERMUSA's goals. However, this technology was complicated and the adaptation to the mobile platform complex. Usability will often mean the difference between life and death in the prehospital community. The technical systems being implemented should not add complexity in caring for patients but add value to this protocol by assisting seamlessly with the care. Acceptance must be achieved before one can expect the paramedic not to fear and be comfortable with the technology. It is just another added step to the standards of care that must be learned and woven into the tapestry of prehospital emergent care.

CERMUSA does not believe the protocol was improperly designed but due to delays in implementation, lost value due to technical upgrades and availability of new modalities for prehospital care. Implementation of this protocol will not be a failure, but we must learn from the mistakes made during this three year commitment. All that has occurred does have value if for no other reason than to tell us what doesn't or won't work or is not acceptable by the prehospital community.

CERMUSA is determined to work closely with Cresson Area Ambulance to adapt the FREC-M to the current radio and data transmission technology available. We will continue to use computer, cellular, satellite, and digital technology to develop and provide the best and most adequate technical monitoring and documentation technology for the paramedic to use for their patients prior to arrival at the tertiary care centers.

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Testbed for Rural Healthcare and Education

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Test Bed for Rural Healthcare and Education

Protocol No. : **05-TATTH208-05**

Date: February 2, 2007

Protocol Title: Test Bed for Rural Healthcare and Education

Principal Investigator: Vicki Pendleton, RN, BSN, MMS

Abstract:
High quality and information infrastructure is important for quality of life and is essential for community growth and development. A viable health sector can be a major component of a community's infrastructure (Doeksen, 2003). Unfortunately rural communities lack such infrastructure which is essential for the recruitment of businesses and economic growth. Therefore it is crucial that rural communities have quality health services for all segments of the rural population.

During the past three years, the Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) and Saint Francis University has been instrumental in developing a rural healthcare enterprise and healthcare education model for southwest central Pennsylvania. This includes collaboration with Miners Medical Center, J.C. Blair Memorial Hospital, Broad Top City and Huntingdon clinics, Lee Regional Health System, Children's Hospital Pittsburgh, PA, Altoona Regional Health System, Memorial Medical Center, Centre County Life Link, Clearfield County Emergency Medical Services (EMS), and Southern Alleghenies Emergency Medical Services Council (SAEMS). SAEMS participants include Bedford Area Ambulance and Cresson Area Ambulance. The model provides high quality, specialized healthcare to the rural and medically underserved populations in three Pennsylvania counties including emergent and non-emergent patients in need of specialty consults at J.C. Blair Memorial Hospital, cardiac patients at Miners Medical Center, and specialty consults, translation services, and physician assistant precepting at the Huntingdon and Broad Top Medical Centers in Huntingdon County, PA. Education services (certification and continuing education) for SAEMS students also continue. With the help of this protocol, CERMUSA continues to build a comprehensive, sustainable model for healthcare, healthcare and wellness education, high quality hospital information technology, and broadband communication access for the rural, medically under-served areas of southwest central Pennsylvania.

Hypothesis:
The specialist outreach, implementation of telehealth technologies, and provision of real-time interactive video-teleconferencing (VTC) for education and specialty consultant services will improve access to healthcare specialties, prehospital education, and technologies used in the care of the rural and medically underserved patients.

Introduction/Background:
The delivery of quality specialty healthcare services and healthcare education to rural populations can be a difficult and challenging process. The rural communities in southwest central Pennsylvania face problems which are present in other rural areas throughout the United States (Freeman, 2002). CERMUSA, in collaboration with SAEMS, Clearfield EMS, Centre County Life Link, Miners Medical Center, J.C. Blair Memorial Hospital, UPMC Lee Regional Hospital, Conemaugh Health System, Broad Top Medical Center, Huntingdon Family Clinic, and Altoona Regional Health System

(Bon Secours) has implemented numerous technical pilot projects for telehealth in the care of adults and neonates, and education for the prehospital provider.

Improving Access to Healthcare:
The long-range goals of a telehealth initiative are to increase access to and quality of healthcare to underserved residents. The short range goals are to establish J.C. Blair Memorial Hospital as the hub of medical expertise linked to four rural clinics, two institutions of higher learning (Saint Francis University and Penn State University) and a home nursing agency in an information network that included mechanisms for interactive VTC, distance learning, continuing medical education, and peer collaboration that is rural-practitioner driven.

Currently, a partnership is in place between CERMUSA and J.C. Blair Memorial Hospital to provide reliable and advanced communication technology for the delivery of healthcare services to individuals residing in rural and medically underserved areas. The initiation of this partnership has resulted in:

- a comprehensive "test bed" that demonstrates advanced medical information technologies that can meet the healthcare needs and requirements of the rural community effectively and efficiently,
- requirements for medical information technologies and related policies and procedures which allowed the hospital to provide extended healthcare access, services and needed education programs to its catchment area,
- identifying the telecommunication and computing technological capacity of the rural "test bed" to meet the needs of the community and its hospitals,
- examination of the characteristics, concerns and networks of individual rural physicians and determined their ability to adopt new medical information technologies, and
- determination of the local community perceptions and the level of community trust and involvement in the local healthcare systems and are better able to understand the consequences of technology adoption and diffusion as well as the ability of the technologies to affect the rural hospital and community viability.

J. C. Blair Memorial Hospital is equipped with an advanced telecommunication telehealth system connecting the hospital with Broad Top Medical Center, Huntingdon Family Clinic and the Altoona Regional Health System. These systems are used by the physicians and physician assistants and maintained by CERMUSA technical staff. Advanced tele-radiology picture archiving and communication system (PACS) at J.C. Blair allows physicians to evaluate diagnostic quality x-ray films in their homes or can be sent to distant reading services.

Miners Medical Center is equipped with a wireless local area network, new computer systems, a laboratory information system, pharmacy PYXIS system and resting/stress electrocardiography technology with data storage allowing the cardiologist to evaluate electrocardiograms from a distance and enter their interpretations and diagnosis to the patient's medical record. The information technology director is trained to maintain and utilize the systems located in Miners Medical Center.

Knowledge of hospital infrastructure and the experience gleaned from working with our partners provides a solid basis for moving out into the rest of the isolated rural areas surrounding CERMUSA. We plan to expand the research from established sites to other healthcare clinics, private practices, and homes through wired and wireless telecommunication systems and telehealth technologies. This includes healthcare applications and wellness programs.

CERMUSA and Saint Francis continue to collaborate with our local partners to provide modern, high quality healthcare, healthcare education and specialty healthcare services to the rural and medically underserved populations in several counties. These partnerships were developed to explore the feasibility, reliability, and the impact of advanced communications and technology and to compare, contrast, and analyze the types of technologies needed to meet the requirements of the community and its healthcare providers (Rae. 2003). CERMUSA continues to support, monitor, and expand the educational and healthcare test bed demonstrating the ability for new medical information technologies to meet the healthcare needs and requirements of the rural population.

Telehealth is an integrated system carrying out healthcare activities at a distance and is increasingly used in an effort to provide high quality, cost-effective care at home (Marineau). Families are expected to provide more complex care to ill family members. As a result, telehealth may become an essential tool in assisting families in transitioning their loved ones from illness to health in the future. Additional research is needed to identify patients who would be good candidates for telehealth in the acute care arena in place of hospitalization. This will contribute significantly to the healthcare industry in offering potentially cost-effective measures in delivering necessary care to a growing aging population.

Smith (2005) studied a relationship between financial factors and the deployment of telemedicine. The urban and rural populations desire to be near medical facilities, but that is not always possible. Demographics of our population are changing and people are living longer. Elderly, sick and uninsured make up a large part of the population, many who have no mode of transportation. Five financial indicators are important: initial or capital investment, operating or ongoing costs, profitability or net income, cash flow, and reimbursement. Reimbursement appeared to be the largest barrier to widespread deployment of telemedicine. The results led to a conclusion that financial indicators do play a major role in decisions related to deployment of telemedicine projects, like many other healthcare projects. Telemedicine is not the sole cured for the rural health dilemma; it can be a major ingredient if aggressively deployed. Providers can use the available technologies and organizations options available and provide specialty care at a reasonable cost (Smith, 2005).

Buckwalter, et al., have shown that telehealth can play a major role for the rural elderly and their caregivers. "Technology-based delivery methods such as videophones and one and two-way interactive computer networks are envisioned as contributors for improving rural residents' access to services, individualizing rural healthcare, increasing rural health practitioners' continuing education opportunities and improving quality and cost-efficiency of care." Rural areas present unique challenges that make service delivery

difficult. These challenges include poverty, isolation, difficulties with transportation, sparse and scattered population and too few human service agencies, trained professionals and healthcare resources. In order to be successful, service providers should offer rural caregivers better coordination of services, improved communication among local agencies, consistent relationships with providers they trust and improved access to healthcare information (Buckwalter, et al, 2002).

EMS Education at a Distance:

The EMS community uses videotapes and satellite broadcasts for continuing education. This allows the healthcare provider living and working far from training centers to access much needed continuing education. Currently, on-line programs and computer based studies are used frequently, giving greater flexibility and information resources to the prehospital healthcare provider.

Initial certification and continuing medical education is a valuable and essential component of assuring competent Emergency Medical Technician/Paramedic (EMT/P) licensure and or certification. The standard EMS curricula require EMS providers to be competent in terms of knowledge, skills, and professional behaviors. Competence must be assured based on initial education and outcomes. State and local protocols require the EMS provider to deliver precise, appropriate patient care on an ongoing basis. As the prehospital professional endeavors to become knowledgeable and proficient in the delivery of prehospital care, it must be realized that continuing medical education is the cornerstone of EMS practice (Prehospital Emergency Care, 2004).

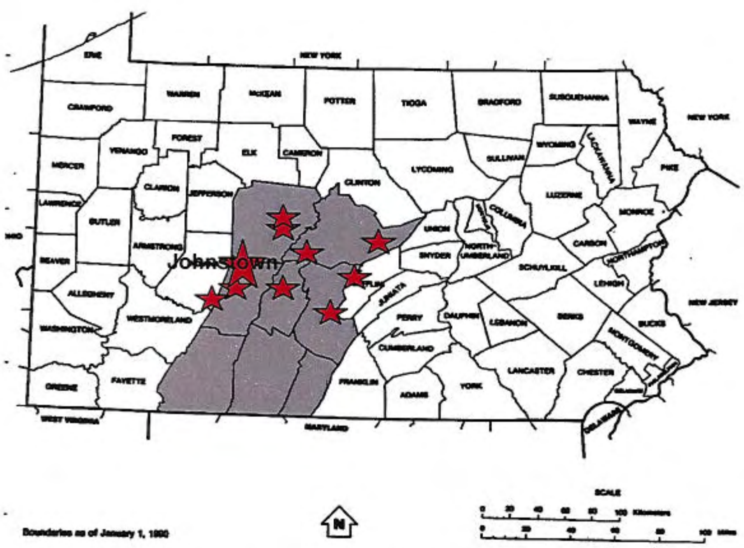
The National Association of EMS educators has taken the position that recertification is and must remain an integral part of maintaining licensure for the EMS professional and should remain at the forefront of the EMS provider's plan for professional growth (National Association of EMS Educators, 2004). The knowledge and experience learned during initial training and education should be evaluated periodically for adequacy and consistency with current medical practice. The EMS professional must be held to a consistent standard of skills and knowledge. Emergency practice changes periodically in techniques, equipment and patient encounters. Recertification should measure the EMS professional's ability to react appropriately to the everyday patient encounter and must also assess his or her ability to manage unusual encounters that appear less often. Throughout EMS education, these individuals are taught to participate in refresher and continuing education to reinforce, update and expand their knowledge and skills (National Association of EMS Educators, 2004).

The National Education Association Research Center has discussed the promise and reality of distance. According to this organization large scale distance education efforts fail because of the lack of student acceptance resulting in lower enrollment, higher costs, and more facility time than expected. They have also determined that distance learning is not cheaper than the traditional "bricks and mortar" education. Blackboard and WebCT (two major platforms for distance education technology) are expensive because of the growing complexity and constant demand for new features and simplicity.
EMS systems are community based health management organizations that are fully integrated with the overall health system, clinics, hospital, and physicians' offices within

their districts. These systems allow healthcare providers to identify and provide care for acute illnesses and injuries; contribute to the care and treatment of chronic conditions, and community health monitoring. The EMS system along with other healthcare providers and public health and safety organizations, improve community health and result in the more appropriate use of acute care and healthcare resources.

Many sponsoring agencies such as hospital and community colleges provide continuing education for the prehospital providers at little or no cost. Unfortunately, distance from these sites or small number of individuals involved in the EMS areas, makes it difficult for the crews to attend these programs in order to obtain the required continuing education. (Figure 1)

Figure 1



The prehospital education program provides continuing education programs and paramedic review and certification from the sponsoring site by real-time VTC to some of the smallest hospitals or ambulance stations located at a closer central site. We believe it has allowed more responders to participate without leaving their primary coverage sites, therefore saving time and money. The number of paramedics varied from county to county. (Table 1)

Pennsylvania Counties in Study	County Paramedics	County Population	Paramedic per population
Blair County	97	127,175	1- 1311
Bedford County	8	49,941	1 - 6243
Cambria County	263	149,453	1 - 568
Centre County	68	141,636	1 - 2083
Clearfield	65	82,874	1 - 1275
Fulton County	2	14,534	1 - 7267
Huntingdon County	8	45,865	1 - 5733
Somerset County	12	79,365	1 - 6614

Table 1

The prehospital community in the SAEMS accepted and welcomed our paradigm. Initial offerings of the paramedic review course and the paramedic certification class were well attended with positive feedback from students and instructors. In the beginning, some students and instructors were concerned about the technology and the mode of the virtual classroom. However, with growing exposure students offered suggestions and ways to improve the system which would work for them with different types of technologies. Past participants demonstrated the technology to be valid for providing education at a distance and made a case for use of interactive communication technologies in the education of their peers in the future.

The VTC system at Memorial Medical Center, which is used as the hub for the paramedic certification and review programs, was maintained and managed by the paramedic coordinator, who was trained and was supported by information technology at CERMUSA. The bridge, which transmits the class to the distant site, was operated by CERMUSA. Similarly, the receiving codecs at the distant sites were also maintained by CERMUSA. At the beginning of the year, a student, chosen by the paramedic coordinator at each site, was trained by CERMUSA to take care and trouble shoot common problems associated with the VTC systems. Each selected student was provided with a laptop computer and free Internet service for the class year.

During the first two years of this study, numerous telecommunication difficulties were encountered by the information technology researchers. Initially, the sites involved in the program were connected by ISDN/T-1 communication lines which were extremely costly. Therefore a decision was made to try alternative communication modalities that were available. During the fall of 2003 and spring 2004 a commercial service was used to transmit the class contents over the Internet Protocol (IP) utilizing the local area networks (LAN) and Digital Service Links (DSL) already in place. Memorial Medical Center communicated over IP to Meyersdale Medical Center and Miners Medical Center. Bon Secours Holy Family Hospital utilized ISDN (at their request) and J.C. Blair connected IP through the use of DSL. The cost of the line charges decreased but the bridging services costs were very expensive.

Because of continued difficulty, different communication modalities were used to maintain the communication connections. It remained costly to provide this service due to the amount of technical support needed and the cost of the commercial bridging service. Costs associated with course delivery included: equipment, installation of lines, monthly fees and costs per minute of the lines. A cost analysis was completed comparing the cost of providing the class against the travel expense of the students in the first paramedic review class. According to this cost analysis, the cost of the equipment, phone charges, and technical support were not sufficiently offset by the savings of student travel expenses to make this program cost effective at that time.

Due to the expense, it was determined that another solution must be found. In the spring of 2003, CERMUSA purchased a multi-communication conferencing unit (Communication Bridge) and implemented the service for prehospital use in the fall of 2003 for the paramedic certification class. The implementation of the bridge here at Saint Francis University allowed CERMUSA to become the hub for all of the

communications of the paramedic certification and review classes in SAEMS. CERMUSA called each site and the bridge connected all of the sites over IP. No local networks were involved. The calls were transmitted at 256 kbps which appeared to be adequate for classroom instruction. Memorial Medical Center and Miners Medical Center were connected over IP (through existing T-1 lines). Bedford and J.C. Blair Memorial Hospital were connected over IP through DSL, and Altoona Regional Health System was connected using an ISDN line. The use of costly ISDN lines by CERMUSA was eliminated and all the sites were effectively managed (and continue to be managed) by one technician.

Students and instructors used WebCT as a tool for handouts, chat rooms and e-mails. This saved time and money for the sponsors and allowed students to prepare for class by downloading study material and assignments. Bridging technology was initiated from CERMUSA, allowing the entire paramedic program to be distributed real-time across IP resulting in significant cost savings to CERMUSA and the participating students.

Methods and Materials:
This was a descriptive, quantitative, qualitative, longitudinal study consisting of two parts: education and healthcare. The program involved all system participants (providers, patients, and students) and monitored all reported data. Anonymity was always maintained. Subjects were recruited from the classroom sites, emergency departments, and participating medical clinics. The subjects were told about the study and if they agreed to participate, were consented by the healthcare provider or instructor.

The education section of this study included prehospital healthcare providers and community populations. Ambulance stations and hospitals were established as education sites. The VTC systems were initially selected for this protocol are the Tandberg 6000 and Polycom FX which are capable of integration by using IP and ISDN. The International Telecommunications Union required set standards for real-time multi-media communications including: H.320 (for ISDN use) and H.323 (for IP use).

ISDN, a digital telephone service, provided rapid and accurate transmission using standard telephone lines with each line consisting of two channels of 64 kbps data transfer rate for a total of 128 kbps of bandwidth. Each ISDN line had a unique phone number assigned to each line. Depending on usage, this appeared to be an expensive option for VTC communication.

The second technology chosen was IP. The IP connectivity used for the VTC contained within the hospital's existing infrastructure. Data was transmitted from one computer to another over the Internet.

The third type of communication exercised for the VTC connect is DSL. DSL is high bandwidth transmission that uses copper telephone wire. This bandwidth is capable of transmitting 512 kbps to 6.1 mbps. A modem must also be installed at the user site to transmit the signal to the Ethernet port on the VTC device though a CAT5 or RJ-45 cable.

Finally, a multipoint control unit (MCU) was purchased which connects one LAN to another LAN using the same protocol. This MCU allows IP and ISDN sites to participate in a VTC at the same time. A maximum of eight participants can maintain a continuous presence throughout the call. All conference participants are seen at the same time. Figure 2 illustrates the communication bridge (Knee, 2005).

Prehospital Education Connectivity
2005-2006

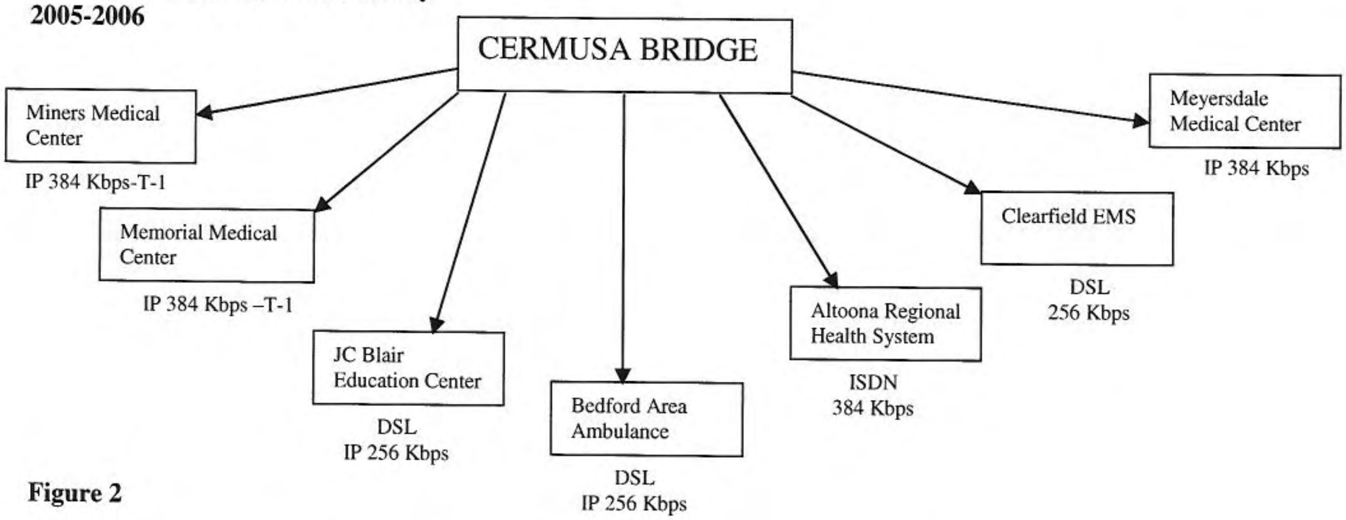


Figure 2

The healthcare section of this study provided medical consultations and precepting to clinicians in rural and medically under-served areas. This protocol was designed to improve accessibility to specialty consultative and precepting services to clinicians in rural areas. This project studied the impact of using telecommunications technology in providing consultative medical services to clinicians in rural and medically under-served areas. CERMUSA worked closely with the rural healthcare providers to establish the infrastructure for the telehealth project and then assisted during the ongoing endeavor.

THE VTC system used at Broad Top, Huntingdon Family Clinic, and J.C. Blair Memorial Hospital was a roll-about unit equipped with multiple patient assessment tools including an otoscope, ophthalmoscope, electrocardiogram, general examination camera and oral camera. These systems are:

- standards-based, and capable of interfacing with other VTC systems that are also standards-based,
- are user friendly and easy to operate,
- provide communication between patient, referring clinician and consulted physician,
- is capable of recording data for future viewing and evaluation, and
- is portable and easily moved from one area to another.

The project at J.C. Blair Memorial Hospital studied the impact of using telecommunications technology to provide consultative medical services to patients and providers in rural and medically under-served areas. The participants completed evaluation forms at the conclusion of the telemedicine consult or meeting. This form rated the technical aspects of the transmission. Those involved were able to document

their opinions of the VTC encounter immediately following the conclusion of the session. The clinician also requested information from the patient, and if unable then their family members provided that information. Responses were scored on a five point Likert scale. Additional space was provided for comments on overall satisfaction, convenience or any related issues.

CERMUSA was involved in monitoring the primary communications infrastructure for this project and assistance during the ongoing project, hoping to establish a county-wide telehealth solution for specialized healthcare.

All telemedicine encounters were evaluated. Upon arrival at the clinic or hospital emergency department, the purpose of the study was explained to the patient/family. If a specialty consult was needed, an informed consent was obtained. If the individual chose not to participate in the study, medical care was provided without the telecommunications technology. At the conclusion of the visit, the evaluating clinician on site, the consulted clinician, and the patient or family member evaluated the session. The following criteria were evaluated:

- audio and video quality,
- clinician comfort with VTC method of precepting,
- patient satisfaction with the VTC method of consult,
- hospital inpatient or outpatient,
- referring physician,
- consulted physician,
- mileage traveled to clinic,
- mileage if traveled to consulted physician,
- use of medical peripheral tools, and
- any diagnostics performed.

The type of equipment used and any technical difficulty encountered during the session was noted. Cost analysis forms were completed and data was used for a business case analysis. All expenditures and savings were tabulated and data were compiled for future use.

Key Research Accomplishments:

- Placement of wireless system throughout Miners Medical Center.
- Installation of electronic classroom at Miners Medical Center.
- Implementation of Cardio-perfect electrocardiogram resting and stress systems in Miners Medical Center.
- Implementation PYXIS Pharmacy system and Laboratory Information System in Miners Medical Center.
- Broad Band connection with VTC capabilities of two rural clinics and J.C. Blair Memorial Hospital in Huntingdon County.
- Provision of cost effective VTC capabilities for rural EMS providers in eight county areas for paramedic certification and continuing education classes.

Reportable Outcomes/Research Results:

EMS Results:

- Provided cost-effective distance learning program for EMS providers for paramedic certification and review classes in eight county areas in Pennsylvania.
- Demonstrated the feasibility, quality, and quantity of encounters and documentation of educational requirements for certification and re-certification through VTC.
- Demonstrated through testing that the prehospital healthcare provider receives the information and verified compliance with the current requirements for continuing education and training.

Improving Access to Healthcare:

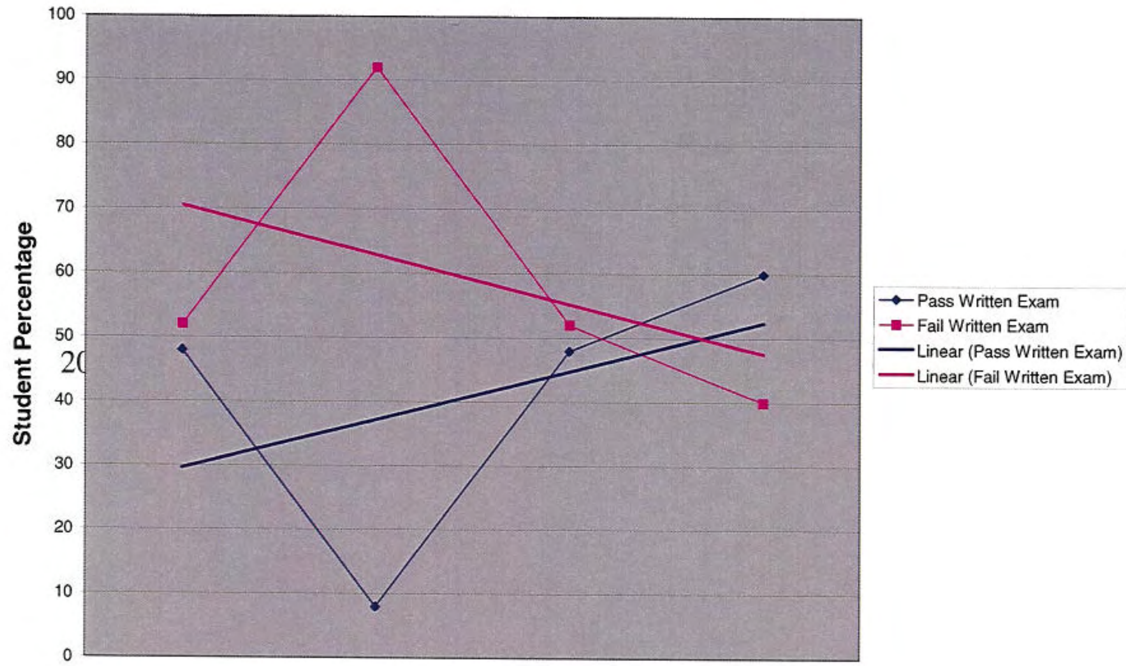
- Demonstrated the ability to provide real-time, interactive communications both synchronously and asynchronously.
- Demonstrated the ability to transmit real-time patient assessment information through data and video transmission.
- Demonstrated the ability to transmit information of clinical relevance, including digital radiology images and real-time digital images.
    - Radiology interpretations at J.C. Blair Memorial Hospital done at a distance by hospital radiology and Night Hawk.
- Implementation of wireless technology in a small rural hospital.
- Successful implementation of stress and resting cardiology access system in small rural hospital with remote access for interpretation and diagnosis by physician.
    - 5431 ECG acquisitions at Miners Medical Center with data base of 2,970 patients.
- Recognized difficulties with utilization of technology by healthcare providers within the hospital and clinic settings.
- Recognized the need for a champion to promote and utilize the available telehealth technology.

Reportable Outcomes/Research Results:

The paramedic certification class has continued to the present with yearly expansion. At this time, distance learning certification and review classes are provided to eight sites in seven counties with expansion expected to Fulton County fall of 2007. It is apparent that until now there has been a general trend suggesting the utility of these efforts. Although no data were collected last year, we believe that the trend would have continued.

Comparison Pass Fail Rate Written Examinations

Figure 3



Comparison Pass Fail Rate Practical Examination

Figure 4

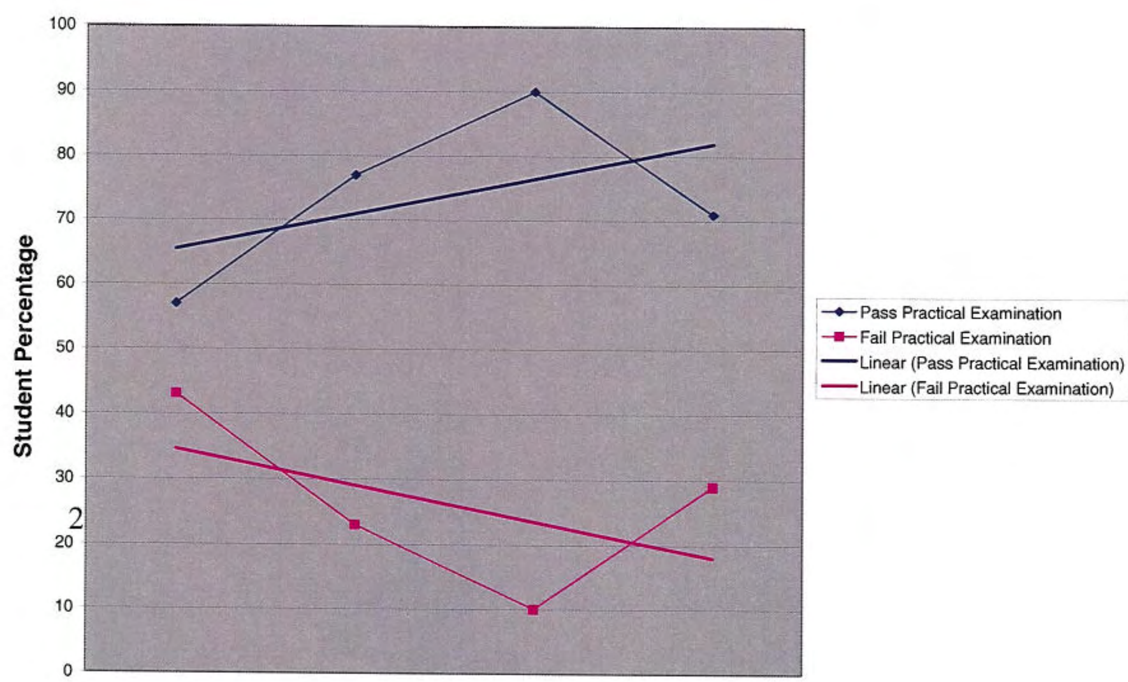


Figure five compares the first time pass rate of the National Registry with SAEMS before and after the initiation of the VTC distance learning program. This comparison shows after the first VTC year, the pass results returned to the previous pass rate.

First Time Pass Rate Comparison/ National Registry vs. SAEMS
Written and Practical Examination

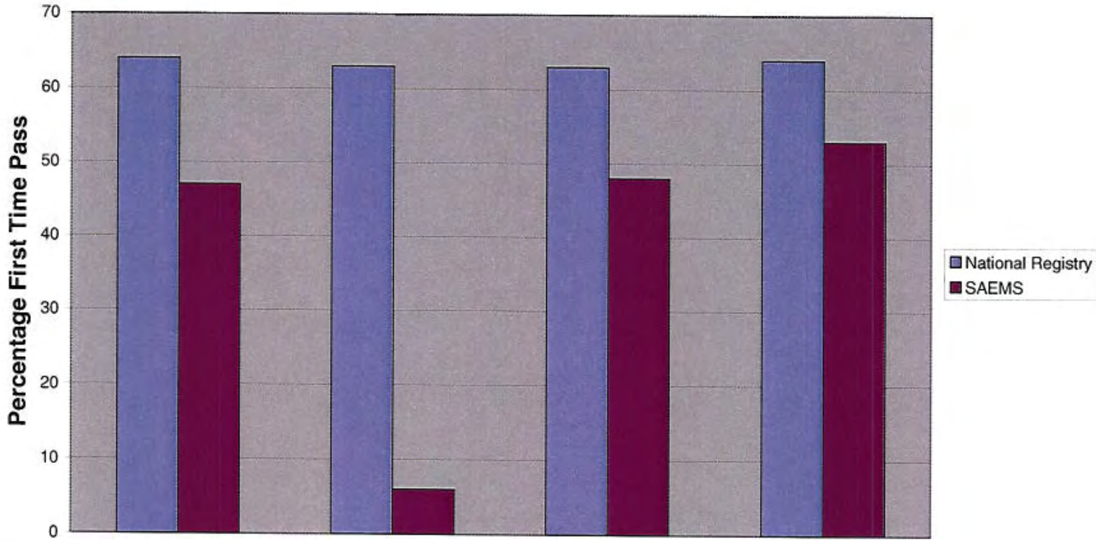


Figure 5

Conclusions/Discussions/Lessons Learned:

Pennsylvania lags in the national effort for reimbursement for telehealth consultations. Although J.C. Blair Memorial Hospital does not have a large staff of specialist physicians, there is no reimbursement process in place to pay for clinical consultations through real-time interactive and VTC. Language interpretation, physician mentoring and the transmission of a video clip to a pediatric specialist are few interactions that have been accomplished since the inception of the program.

Past experience suggests that large scale distance learning efforts increases the likelihood of failure mainly due to lack of a student acceptance, low enrollment, increased use of faculty and higher costs. Some students miss the social structure and lack of interaction with faculty and other students can decrease motivation and responsibility (Update, 2002). It is conceivable that the students feel isolated, lose interest over time, experience frustration and a number of other emotions. It is apparent that self motivation is important for success. Self-directed education requires certain support to facilitate learning which should be based on the needs of the student. A typical distance learning student is ≥25 years, employed, and has previous work experience (Update, 2002). More than half of these students in our study group were females and highly motivated, committed and disciplined (Update, 2002).

During this current study, research discovered that the majority of the students were male, ≤30 years old and had no prior college education (Table 2). The cost of the EMS

program is uaually less than college tuition and could be finished in a year. Some of these individuals may not have been serious about the education as a result did not study.

Number of Paramedic Students and demographics from 2000-2005

Class	Total Enrollment	Student Retention	With draw	Mean Age Students (Years)	Some College Credits	Associate Degree	Bachelor Degree	Master s Degree	RN	LPN
2000	24	16	8							
2001	18	16	2							
2002	34	20	14	27.1	3	0	2	0	0	0
2003	23	17	5	26.8	2	1	3	0	2	1
2004	29	21	8 *	27.5	8	3	1	0	0	0
2005	28	17	11 *	28.32	4	1	2	1	0	1

* Lost to active duty

Table 2

The paramedic certification program has changed drastically during the past four years. The implementation of VTC using IP has decreased the communication costs. Students and faculty have become more comfortable with the technology. Real-time distance education for paramedic certification has great potential and can provide a rich study environment for a student. The program has become successful and sustainable. The paramedic certification and review programs are serving an unmet need for the rural area because it has provided specific training to the student who otherwise may not be able obtain this education. We feel that this study provides an opportunity for people in under-served counties such as Somerset, Huntingdon, and Fulton to obtain training to become certified paramedics. The EMS system along with other healthcare providers and public health and safety organizations could improve community health and result in the more appropriate use of acute care and healthcare resources.

Despite the training and revisions carried out for practitioners at J.C. Blair Memorial Hospital, Broad Top Medical Center and Huntingdon Family Clinic, the use of telehealth technology has been less than favorable. The two clinics use the VTC for board meetings but have not consistently done any physician assistant mentoring or specialty consults with the patient population. The hospital has not done any significant specialty consults either. The project has not worked as expected. The cause is probably multifaceted. It appears that the clinicians found the technology difficult to integrate into their practice on a daily basis. The practical and logistical difficulties encountered with these systems apparently became a huge barrier to the practitioners causing them to lose their clinical flexibility. Complexity of the telehealth system can exist at four separate levels. They include:

- implementation of the service,
- adoption of the service by the practitioner,
- bringing telehealth technology into everyday practice, and
- development of new procedures to accommodate the new telehealth technologies.

A breakdown in any of these levels can lead to program failure. The clinicians must develop an ownership of the program, be flexible in integrating the technology into their practice so that it ceases to become a special service and instead becomes a necessity similar to the telephone, facsimile, and computer. Normalization of telehealth as an everyday tool must occur.

We are becoming more dependent on this technology and as researchers, we must become more cautious in designing protocols and projects that use new technology. The prehospital education portion of this protocol has been a resounding success while other segments of the protocol have been slow to become part of the healthcare. We would hope that in discussing the lessons learned through this project, we can turn the failures into a success story.

During 2006, the IRB approval was not received until the latter part of the year. As a result, data were not collected. We wanted to show that the continual trend of the usefulness of these technologies in the rural setting, especially for the paramedics certification program. Suffice to say that we have no doubt that if we were able to collect data points, this trend would have continued.

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Improving Wound Care Management

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Improving Wound Care Management Through Video Teleconferencing Technologies

Protocol No.: **05-TATTH210-05**

Date: February 2, 2007

Protocol Title: Improving Wound Care Management Through Video Teleconferencing Technologies

Principal Investigator: Gina Litzinger, RN, MSN

Abstract:
Chronic wounds are a major healthcare crisis, presenting challenges for home health agencies lacking specially trained staff to properly monitor and manage these wounds. Consequently, the home health industry needs to improve wound management methods and technologies to properly care for patients with chronic wounds. Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) collaborated with the Home Nursing Agency (HNA) to investigate the benefits associated with implementing technology to improve chronic wounds. The challenge was to improve patient outcomes through more frequent specialized wound evaluations and identify opportunities to improve productivity and cost savings for the home health agency.

Introduction/Background:
The home health industry needs to improve wound management techniques and methods in order to properly treat patients presenting with severe chronic wounds. It is estimated that 5 million people in the United States suffer from chronic wounds, with 1.5 to 1.8 million new wound cases added each year (Buckley, Tran, et al, 2005). Chronic wounds account for 31-36% of patients in home care, with approximately half of these patients having multiple wounds (Buckley, Tran, et al, 2005). United States healthcare providers spend $20 billion to $25 billion dollars per year to treat chronic wounds (Korzeniowski, 2006). The incidence of chronic wounds will only continue to rise as the population ages. The skin of older people is more easily damaged, and older cells do not proliferate as fast and may not have an adequate response to stress in terms of gene upregulation of stress-related proteins (Mustoe, 2004). In addition conditions such as diabetes, poor circulation, neuropathy, systemic illness, and prolonged periods of immobility contribute to skin breakdown resulting wounds.

Healing wounds at home costs approximately $13,000 per treatment episode (DiCianni & Kobza, 2002). Chronic wounds are also responsible for 50-70% of amputations, resulting in billions of dollars in healthcare costs (Visco, et al, 2001). Depending on the level of amputation, the costs for lower-extremity amputations approaches $30,000-$33,500 (Tennvall & Apelqvist, 2004). Unfortunately the shortage of Wound Ostomy Continence (WOC) Nurses is reaching a point of national crisis, forcing WOC Nurses to manage disproportionately heavy caseloads (DiCianni & Kozba, 2002).

Effective and timely management of chronic wounds can significantly delay or eliminate the need for limb amputations and surgical interventions, significantly reduce hospital admissions and substantially reduce costs related to care. Proper management of chronic wounds requires frequent, routine monitoring for wound healing progress to optimize healing and ensure early recognition of impending complications (Gardner, Frantz, et al. 2001). The development and implementation of wound treatment plans depend on adequate wound assessments, as well as the patient and its support structure. Frequent wound assessments by a wound care specialist may help the specialist to adapt treatment strategies to accommodate changes in the wound status that otherwise would not be identified.

Managing chronic wounds should include education on wound care management and nutrition because it could reduce or eliminate the risk of infection, ensure proper dietary requirements for wound healing, and instruct the patient and caregiver(s) when to seek medical intervention. Timely institution of prophylactic and corrective measures in wound care management can help prevent or slow the progression of pressure ulcers, thus improve the quality of the patients life while minimizing use of healthcare resources (Dharmarajan, T., & Ahmed, S., 2003).

CERMUSA will partner with HNA because it has several offices in Center, Cambria, Bedford, Blair, Huntingdon, Franklin and Fulton counties, and offers extended coverage in parts of nine additional counties. These counties are covered by one WOC Nurse who must travel across this region to evaluate wounds. Due to considerable travel time, the WOC Nurse is idle and unable to evaluate wounds, therefore leading to inefficiencies and extended service costs. This protocol is designed to minimize idle time. We have proposed to evaluate severe wounds using video teleconferencing equipment and advanced camera technology which will allow the WOC Nurse to conduct wound evaluations at a distance, resulting in decreased travel.

Digital photographs provide a permanent record for following the patient's healing status. A study by Kinsela concludes: "Use of digital cameras in wound care is a new and needed trend in home care. At this more advanced stage of their development (after trials elsewhere), off-the-shelf digital camera brands familiar to nurses in their personal life are easy to use and provide accurate quality depictions of wound status"(Kinsella, 2002). The proposed protocol gives insight to the benefits of pursuing video teleconferencing as an adequate means of providing specialized wound consultations. A similar study established that remotely based nurses could access nursing expertise to improve patient care by interacting with the wound care specialist resulting in improved assessment skills (Gardner, Frantz, et al. 2001).

We predict that the use of video teleconferencing (VTC) to assess wounds and establish treatment regimen by home health nursing staff will improve wound healing, satisfy the patient and the nursing staff, and will decrease the costs associated with conventional wound care methods.

Methods and Materials:

The wound care protocol is designed to explore the feasibility of conducting wound evaluations through the use of VTC technology. The goal is to assess the effects the new processes and technology has on the costs associated with providing wound consultation. Productivity and efficiency of WOC Nurses will also be evaluated. Lastly, the prototype strives to find a sustainable solution that would improve patient outcomes.

Healthcare staff participants are selected by HNA administration. All participating healthcare staff are trained to handle the equipment provided by CERMUSA, as well as, the policies and procedures drawn by HNA. Once trained, the two selected locations (Altoona and Ebensburg) will perform in-house mock wound care visits before conducting actual patient visits.

Patients with Stage III or Stage IV pressure ulcers, and/or infected wounds will be offered the opportunity to participate in the video wound care program. During regularly scheduled skilled nursing visits, the patients' primary nurses will explain the risks, potential discomforts, benefits of the wound video program, and answered questions pertaining to the study prior to obtaining

the patient's informed consent. Afterwards, the patient's RN Case Manager or the WOC nurse will complete the wound video enrollment cover sheet.

Video visits will occur weekly during one of the patient's scheduled dressing changes. Videographers, under the supervision of the WOC nurse, will only be responsible for the video portion of the wound care video visits. The individuals responsible for the wound care, either the HHA nurse or the patient's caregiver will be present at these visits. They will provide the wound care at the end of the video portion of the visit after listening to the suggestions of the WOC nurse.

Utilizing the portable kits, the videographer will call from the patient's home to the WOC nurse back at the office. After establishing the call, the WOC nurse will verify proper patient identification with the aide. Aides will complete logs containing pertinent information linking the patient, date of visit, and picture in the memory card.

The WOC nurse will maintain contact with the home health aide in the home to determine/ensure accurate video visit transmission. At the direction of the WOC nurse, the aide will capture the images as digital photographs stored on the memory card. The WOC nurse will make suggestions about the existing wound care treatment methods as appropriate. At the completion of the work day, the aide will deliver the memory card to the WOC nurse at the distant site, who will download the picture to the computer. The WOC nurse will print images from the memory card, place the patient's name on the photograph(s) prior to filing them in the patient's clinical record. The WOC nurse will then erase the pictures from the memory cards, to enable more storage for future photographs. This will also be done to maintain patient confidentiality in accordance with the Health Insurance Portability and Accountability Act of 1996.

After each visit, videographers will complete wound video visit notes. Nurses responsible for wound care will document dressing change observations, and WOC nurses will document wound care recommendations. Recommendations will be forwarded to the case manager or primary nurse who will obtain physician orders when a change in treatment is suggested. If necessary, the WOC nurse will schedule follow up wound video visits based on the severity of the patient's wound, and if new treatment changes are needed. Upon discharge from the wound care video service, patients will be asked to complete a survey.

Staff at Home Nursing Agency will be asked to calculate time and miles saved using this wound video program. In addition, staff will be asked to complete surveys pertaining to their thoughts on the use of the study equipment, benefits to the patient, and benefits to the organization.

Study Equipment:
Portable kits consisted of: a set of speakers, a videophone, a camcorder, ten memory sticks, a three-prong adapter, a fifty-foot phone cable, an audio/video cable, a power cable for the camera, a surge protector/power strip, a four-prong phone adapter, travel tripods, extension cables, and video lights.

Receiving base stations consisted of: a television/video cassette recorder combination, a video phone, a card reader, a computer monitor, a personal computer, a keyboard and mouse, a printer, an amplifier and a microphone.

Although a majority of the equipment for the FY05 wound care study was part of CERMUSA's inventory from previous wound care studies, there were additional items needed to execute the current study. Several adapters, ink cartridges, a battery, and battery adapter for the camcorder needed to be replaced due to damage or loss from the previous years study. The total costs for this additional equipment was approximately $337.00.

Key Research Accomplishments:

- Wound care study equipment installed in the Altoona and Ebensburg HNA offices.
- Study personnel at HNA trained on the use of the study equipment.
- HNA recruitment of study participants.
- Educational sessions regarding the availability of this project were conducted at HNA for the agency staff.

Reportable Outcomes/Research Results:

Recruitment of study patients and educating the agency staff about the availability of this project is in the primitive stages at HNA. Due to circumstances beyond the researchers' control, there are no patients currently enrolled in this study and therefore no results to interpret.

Conclusions/Discussions/Lessons Learned:

Due to HNA's unfamiliarity with research processes and procedures, there were numerous delays with the implementation of this research process. Additionally, scheduling conflicts and case loads contributed to the delayed implementation of this study.

Installation and training of the study equipment occurred at the end of October 2006. As stated earlier, HNA staff agreed to begin in-house mock wound care visits before conducting live patient visits. HNA staff also agreed to make test calls to the CERMUSA test lab. To date, practice sessions have not been completed despite weekly email and phone communications on the part of CERMUSA researchers. CERMUSA researchers are optimistic that this study will become fully implemented in the next month.

Prior to this research prototype, the HNA conducted wound care consultation by sending WOC Nurses to the patient's home in a traditional house-call fashion. Using traditional wound care consultation methods, WOC Nurses were only able to see several patients a day. Patients seeking wound care specialist consults were only seen several times a month. Using this wound video program, patients could potentially be seen daily by the WOC Nurse, allowing for increased wound care assessment and intervention.

Rural and medically under-served areas are in need of improvements in wound assessment, treatment, and evaluation techniques to offset barriers such as inclement weather and tedious travel to clinicians. Improvements in assessing, treating, and evaluating wound care through video teleconference may improve medical outcomes for patients suffering from chronic wounds, improve the quality of life for these patients, and diminish the economic impact of chronic wounds on an already overburdened healthcare system. Secondary outcomes such as non-traumatic amputations may be prevented, while widespread use of this protocol would diminish costs for third party payers such as Medicare.

Extensions/Stretch Goals:
This study brought about the formation of a new partnership with CERMUSA and HNA. Although this study is in the working phases at HNA, CERMUSA researchers and HNA administrators continue to examine outcomes from the prior wound care study to aid in determining future phases of this project. There is mutual agreement between CERMUSA and HNA to continue research focusing on patient outcomes using a standardized wound assessment tool combined with nursing best practices and VTC visits. CERMUSA and HNA are seeking to determine how the healing times for chronic wounds treated via conventional wound care practices compare with wound care healing times utilizing telemedicine applications.

In addition, future studies using video teleconferencing to observe and evaluate the nurse/caregiver's skill related to proper wound care techniques would be beneficial for determining areas of improvement. Improving the accuracy of wound assessment and consistency of treatment would help to ensure proper care is performed, resulting in a more accurate diagnosis and more appropriate treatment. CERMUSA researchers meet monthly with HNA to discuss future phases of this study.

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TIDE

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Telehealth Innovations in Diabetes Endeavors

Protocol No.: **05-TATTH209-05**

Date: February 2, 2007

Protocol Title: Telehealth Innovations in Diabetes Endeavors

Principal Investigator: Camille Wendekier

Abstract:
The need to have a diabetes registry in the rural outlaying areas is a growing concern for rural America. With increase in incidences of diabetes and related health issues on the up-rise, it is important to monitor or document all of the patient's healthcare concerns. The means for entering the patient data into a single database can resolve this ever growing issue. Using a chronic disease registry, medical providers can offer support care management to their patients. It can capture and track primary patient information which could be used for proactive management for patients.

Disease registries allow physicians not only to make individualized notes on patient records, but also allows the clinician to run queries to identify subpopulations within his/her practice that may be at high risk of developing secondary complications to diabetes. In addition, a registry would also allow clinicians to monitor and control the quality of their own practice.

During the course of this project an alternative source for funding was identified; therefore, Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) did not execute this project under the auspice of TATRC.

Introduction/Background:
Chronic conditions, such as diabetes, afflict millions of Americans, and are the major cause of illness, disability, and death in the United States (Metzger, 2004). Approximately 18.2 million people (6.3% of the United States population) have diabetes (National Institute of Diabetes & Digestive & Kidney Diseases, 2004). The number of new cases of diabetes increased 47% from 1997 through 2002, with approximately 1.3 million adults receiving a new diagnosis of diabetes in 2002 (National Center for Chronic Disease Prevention and Health Promotion, 2004). The risk for death among people with diabetes is approximately two times that of people without diabetes (National Institute of Diabetes & Digestive & Kidney Diseases, 2004). Danaei, G. et. al. (2006) have shown that elevated blood glucose levels accounted for 21% of all ischemic heart disease deaths and 13% of all stroke deaths world wide.

Diabetes affects society in many ways: lost workdays, restricted activity due to permanent disability and mortality. The indirect cost of these consequences is estimated to be $39.8 billion in 2002 (American Diabetes Association, 2003). Direct medical expenses related to diabetes and its secondary complications accounted for $160 billion in 2002 (American Diabetes Association, 2003). The secondary conditions related to diabetes include heart disease, stroke, blindness, renal disease, and non-traumatic limb amputations. During 1992-2000, it was estimated that diabetes and its secondary conditions have cost approximately $58.6 billion in lost wages due to early retirement, sick days, and disability for those born between 1931 and 1941 (Medical Letter on the CDC & FDA, 2004).

Although research aims to find a cure for diabetes, clinicians can thwart some of diabetes' unsolicited outcomes. Secondary and tertiary prevention measures would entail early diagnosis of Type 2 Diabetes and prevention of diabetes related complications through the maintenance of optimum blood glucose levels. An economic meta-analysis of diabetes and diabetes care shows

that appropriate treatment for diabetes may prevent further complications and/or functional losses for patients, while diminishing the medical costs associated with diabetes (Zhang, Engelgau, Norris, Gregg, & Narayan, (2004)).

Many deficiencies in the healthcare system prevent diabetic patients from receiving preventative screenings, education, and proactive treatments. These deficiencies, which often hinder the healthcare team's ability to follow established treatment guidelines, include lack of care coordination, lack of follow-up care, time constraints faced by many practitioners, and patients inadequately trained to manage their chronic disease (Improving Chronic Illness Care, 2004a). A comprehensive approach to diabetes management can assist clinicians to diminish these deficiencies and improve delivery of care.

Dr. Ed Wagner's Chronic Care Model summarizes the basic elements for improving chronic care within health delivery systems and strives to promote healthier patients, increased provider satisfaction, and cost savings. This model identifies the community, the health system, self-management support, delivery system design, decision support and clinical information systems as essential elements of a healthcare system that encourage high quality chronic disease management (Improving Chronic Illness Care, 2004b).

By supplementing patient medical records and facilitating completeness, availability, and organization of patient information, disease registries become an essential component within a clinical information system (Metzger, 2004). The registry's basic function is to be a support mechanism for the delivery of chronic care by applying patient-specific information at the point of care, identifying patients with gaps of care, identify patients who need follow-up care, and provide status reports that act as feedback to physicians regarding their performance and to track programs with population management (Metzger, 2004).

Ever since its adoption of a registry, Laurel Health Systems (Tioga County, PA) has seen registry's dramatic impact on diabetes management due to immediate and long-term improvements in diabetes treatment outcomes. Clinical improvements included lower HbA1c and cholesterol levels within the patient population. Economic benefits included increased primary care revenue and cost savings for averted stroke, myocardial infarction, or coronary artery bypass grafting. The cost savings were estimated to be $10,000 - $20,000 per occurrence (United States Department of Health & Human Services, 2003, pp. 117-118).

In past CERMUSA has successfully demonstrated the ability to import blood glucose logs from an analogue modem into a secure database. This technology reduced the isolation of homebound patients from their healthcare providers. CERMUSA researchers planned to import blood glucose record-logs from the patients' homes into the registry application. CERMUSA researchers also wanted to import data from body monitors worn by the patient into the disease registry. The ability to readily access accurate blood glucose logs may improve the clinician's ability to medically manage diabetes, and therefore, prevent or delay the secondary complications of diabetes..

Hypothesis:

The implementation of a diabetes registry will improve patient clinical outcomes and gain access to secondary screenings and services.

Expected results from study were as follows:

- Change in rates of diagnostic tests such as HbA1c, LDL, and Cholesterol.
- Change in the absolute values of diagnostic tests such as HbA1c, LDL, and Cholesterol.
- Change in rates of screenings, such as eye and foot.
- Change in absolute value of diagnostic measures such as blood pressure and weight.
- To diminish diabetes related distress as indicated by change in The Problem Areas in Diabetes scale (PAID) for patients utilizing home modems and/or wearable body monitors.
- To improve reported perception of quality of life (QOL) as indicated by change in the Center for Disease Control and Prevention's Health Related Quality of Life Measure (HRQOL-14) for participants utilizing home modems/and or wearable body monitors.
- Utilization of patient education resources via the internet and kiosks.

Technical Objectives:

- To demonstrate the feasibility, reliability, and accuracy of implementing a disease registry for two remote clinics.
- To demonstrate the feasibility, reliability, and accuracy of importing blood glucose logs from analogue modems to the registry database.
- To implement an Internet patient diabetes education module and investigate the capabilities of importing data from the module into the registry.
- To investigate the ability of importing data from wearable body monitors into the disease registry.
- Correlate blood glucose levels with physiologic measures collected by the wearable body monitor that include heart rate, caloric intake, and caloric burn.
- Archetype blood glucose levels with physiological parameters such as heart rate and galvanic skin response via a 24 hour trial.

Methods and Materials:

CERMUSA partnered with Dr. Timothy Jackson, M.D. and the Uniontown Hospital to implement this research protocol. Dr. Jackson is the primary endocrinologist in Fayette and Greene counties. It was proposed that the registry would be set up by utilizing a server located at CERMUSA. Shortly after establishing this partnership, Dr. Jackson moved his practice out of state. Because Dr. Jackson was the primary partner in this research project, CERMUSA was unable to execute the projected research plan until new partners were identified. Following five months of extensive searching, CERMUSA identified two practitioners who will conduct the research project with us. Once the partnerships were established, the next eight weeks entailed obtaining signed documentation delineating the relationships between the partners and CERMUSA.

We planned to recruit a convenience sample from our new clinical partner's practice. Multiple sources such as automated data, chart audit, and patient encounters were to be used to recruit participants. The study population was to provide informed consent prior to participating in the protocol. To qualify for participation in the study, participants must have consented to the use of all collected data (without identifying information) for research and reporting processes. It was planned to store all data in a secure file at CERMUSA in compliance with the Health Insurance Portability and Accountability Act (HIPAA) of 1996 regulations. Computer data files were to be stored in compliance with security procedures.

Once data has been entered into the registry software, the partnering clinician, the clinic's office staff, and CERMUSA researchers planned to establish a set of queries to determine routine care needs for the study population. These queries were to be utilized to plan schedules to deliver proactive diabetes care. Automated templates of individual patient summaries were to be used at the time of patient office visit.

Data was to be entered into the registry for twelve months; the length of the study. Prior to collecting the data for analysis, the data was to be de-identified by removing all personal information such as name, address, telephone number, social security number, and medical insurance numbers.

CERMUSA also planned to develop the capability of importing blood glucose logs from participants' glucose meters into the database via analogue modems and conducting a small pilot study with 35 participants. The sample would have been recruited from patients previously enrolled in the study. Informed consent and baseline information (HbA1c, BMI, blood pressure, demographic and medical) history was to be obtained when receiving the modem and when the modem is returned to the researchers. Participants were to use the modems for approximately six months.

CERMUSA researchers also intended to deploy an Internet diabetes education module. Hits to the site were to be tracked in addition to tracking hits from patient education kiosks deployed throughout Fayette and Greene County. Information was also to be obtained from this Internet education module on the ability to save post test scores and evidence of completing the education. This data will then be analyzed to determine if it is possible to import the data into the registry.

CERMUSA researchers planned to investigate the use of wearable body monitors. Research goals for these monitors focused on their ability to:

- Provide support and feedback to participants to assist them in management of their diabetes.
- Assess if they have any effect on HbA1c levels, BMI, and blood pressure.
- Have the ability of importing physiological data into the registry.

The participant sample for researching the wearable body monitors was also to be obtained from the partnering clinician's practice. These participants may or may not have been in the sample population of the registry. Informed consent and baseline information (HbA1c, BMI, blood pressure, demographic and medical) history was to be obtained when receiving the wearable body monitor and when the monitor is returned to the researchers. It was intended that the participants wear these monitors for 90 days..

Electronic patient information was to be kept confidential according to HIPAA mandates. All data used for CERMUSA reports would have been de-identified to maintain participant anonymity.

Data analysis would have examined patient characteristics and distributions at the start and end of the study. After the 12 month study was completed, data analysis would have assessed for

change in mean levels and numbers of tests per twelve months, screenings per twelve months, and differences in other diagnostic measures such as blood pressure and weight.

CERMUSA received alternative funding to execute the study. Therefore, the study titled, Telehealth Innovations in Diabetes Endeavors was withdrawn from Army USAMRMC HSRRB review.

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Utilizing Technology to Promote QA & QI

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Utilizing Technology to Promote Quality Assurance and Quality Improvement Activities in Rehabilitation Facilities (NCSOCRC)

Protocol No.: **05-TATTR211-05**

Date: February 2, 2007

Protocol Title: Utilizing Technology to Promote Quality Assurance and Quality Improvement Activities in Rehabilitation Facilities (NCSOCRC)

Principal Investigator: Eric S. Muncert

Abstract:
Utilizing Technology to Promote Quality Assurance and Quality Improvement Activities in Rehabilitation Facilities is a continuation of an existing protocol to determine if using telecommunications and computing technologies is cost-effective, educational, and enhances collaboration among rehabilitation centers. Research for this protocol continued in 2006 with the broadcast of Saint Francis University staff presenting four one-hour Microsoft workshops via video teleconferencing (VTC) to the nine members of the National Consortium of State Operated Comprehensive Rehabilitation Centers (NCSOCRC). The nine state related centers serve clients in rural and medically under-served areas throughout the United States. The VTC equipment and technologies necessary to broadcast these courses were previously installed throughout the NCSOCRC by the National Telerehabilitation Service System (NTSS). The use of the Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA) Tandberg Multipoint Control Unit (MCU) established communication links throughout the NCSOCRC. Testing is continuing with this technology, utilizing Internet Protocol (IP) which can further reduce connectivity expenses. Individuals participating in the workshops registered through WebCT and completed a survey following the conclusion of the workshops. Participants evaluated the overall activity and items were scored on a five point Likert Scale.

Introduction/Background:
The NTSS initiative capitalizes upon the extremely successful results of a collaborative proof-of-concept telerehabilitation research study carried out by CERMUSA with the Hiram G. Andrews Center (HGAC), located in Johnstown, Pennsylvania. A member of the NCSOCRC, HGAC is a state operated comprehensive rehabilitation facility that does not discriminate to individuals with disabilities. The recent convergence of telecommunications and computing technologies has provided the opportunity to develop new, innovative, and cost-effective strategies to support, promote, improve, and advance services for persons with disabilities.

The NCSOCRC is comprised of nine state operated rehabilitation centers located in Arkansas, Georgia, Kentucky, Maryland, Michigan, Pennsylvania, Tennessee, Virginia, and West Virginia. Its mission is "to promote and assure quality rehabilitation services at America's state operated, comprehensive rehabilitation centers that result in employment and independence for individuals with disabilities" (NCSOCRC, 1995). The Americans with Disabilities Act (ADA) requires public facilities and agencies to provide reasonable accommodations for people with disabilities. "Reasonable accommodations" are defined as modifications to policies, practices, and procedures that will allow services to be provided to persons with disabilities (ADA, 1990).

It is believed the telecommunications technology among comprehensive rehabilitation centers will continue to increase the sharing of expertise and/or model programs in staff development between centers.

This protocol uses telecommunications and computing technologies to allow occupational therapists, recreation therapists, instructors, rehabilitation counselors, and directors of vision

impairment programs to share information and resources. "Video teleconferencing is the two way transmission of both audio and video between the interaction of two or more sites for college classes, virtual field trips, school meetings, healthcare workshops, and industry and business meetings from different areas of the world. This technology brings the world to our door" (Impact Learning Center, 2003). This protocol is also designed to facilitate and/or improve administrative communication and/or screening activities among facilities. The lessons learned in this protocol demonstrate to staff members of the various NCSOCRC that efficient and cost-effective education alternatives for sharing information can be developed. "The NTSS has provided each of the nine centers with telecommunication technology to link the centers for staff education and video teleconferencing purposes" (David Holmes, Superintendent, Tennessee Rehabilitation Center and NCSOCRC Chairman, NTSS news, 2005). Distant learning collaborations between and among educators and students creates an ability to share knowledge through a "network of regional networks" intended to improve access to, and the quality of, educational offerings provided for schools, as well as graduate and professional school preparation (Kentucky Department of Education, 2003).

During the 2006 research period, the NTSS continued to build its relationship with the NCSOCRC. Broadcast from Saint Francis University, staff presented four one-hour Microsoft workshops via VTC to the nine members of the NCSOCRC.

Workshops completed within the protocol included:

- Absolute Beginning of Microsoft PowerPoint
- Creating an MS PowerPoint XP Slideshow from Scratch
- Microsoft Excel Basics
- Microsoft Excel Beyond the Basic.

Methods and Materials:

The continuation of the project studies the impact of utilizing technology to promote and enhance administrative communications, share telemedicine applications and technologies, assist in the development of educational environments, and provide clinical dialogue, quality assurance and quality improvement activities in and among rehabilitation facilities, specifically NCSOCRC.

The provided telecommunications and computing technologies allow therapists, instructors, clinicians, counselors, other staff members and NCSOCRC directors to share information and resources. The equipment necessary for video teleconferencing was previously installed throughout the NCSOCRC by the National Telerehabilitation Service System (NTSS). The use of the CERMUSA Tandberg Multipoint Control Unit (MCU) establishes communication links throughout the NCSOCRC. Testing is continuing with this technology utilizing Internet Protocol (IP).

Subjects participating in the study are staff members or contract employees at each NCSOCRC facility who evaluate the technology or education and its application related to the research protocol and their individual job responsibility. Subjects are over 18 years of age. Recruitment for participation in the research is based upon the content matter of the video teleconference and participation is determined by the directors of each facility.

Key Research Accomplishments:

The accomplishments from this research include:

- Determine benefits from using video teleconferencing within the NCSOCRC.
- Determine cost-effectiveness of video teleconferencing between the NCSOCRC located in nine states.
- Determine practicality of utilizing video teleconferencing technology between the centers.
- Determine if telecommunications assists in facilitating and enhancing administrative, clinical dialogue, and quality assurance among the nine member centers of the NCSOCRC throughout the United States.

Reportable Outcomes/Research Results:
The ability of providing technologically and visually appealing, innovative, and cost-effective education programs in 2006 was tested in rehabilitation centers. Utilizing video teleconferencing and computing technologies to enhance education for their staff through the use of the Tandberg Multipoint Control Unit, Saint Francis University's Instructional Technology Specialist conducted four different one-hour Microsoft PowerPoint and Excel workshops that were broadcast throughout the NCSOCRC. The different workshops were broadcast on separate days throughout 2006. One hundred sixty-one (161) individuals registered via WebCT, accessed the class materials on the Internet, and participated in the continuing education workshops. One hundred participants voluntarily participated in the research study and completed the Software Education Questionnaire. Information received from three NCSOCRC directors indicated a savings of $150 per employee would be realized had this type of training been held away from their facility. This represented a savings of $24,150 throughout the consortium.

Using a five point Likert Scale: 5 = Excellent; 4 = Very Good; 3 = Good; 2 = Fair; 1 = Poor; each participant evaluated the following:

N= 100

Questions	Likert Rating
1. How well the activity met the stated learning objectives	3.89 ± 0.96
2. How well the activity related to your position duties	3.67 ± 1.03
3. How well the activity will help you improve your position duties	3.70 ± 0.98
4. How well the instructor conveyed the subject matter	4.02 ± 1.01
5. The overall quality of the activity	3.81 ± 1.08

Conclusions/Discussions/Lessons Learned:
The protocol demonstrated to staff members of the NCSOCRC that efficient and cost-effective education alternatives for sharing information can be developed. Video telecommunications increases access to healthcare and education in isolated, rural, and under-served communities. Sharing areas of expertise or model programs remotely using technology results in reduction of center costs for employee training and education.

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Extensions/Stretch Goals:
Additional projects utilizing video teleconferencing technology planned throughout the NCSOCRC include the consortium's desire to develop specific distance learning workshops as to areas of expertise at each center that would be offered to all consortium member centers to help meet staff training needs. Developed from within the consortium, the "NCSOCRC Training Academy" will begin in the first quarter of 2007. The use of the technology will also continue with each center's director and designated staff participating in quarterly or as needed administrative meetings. Designated as a Microsoft Accessibility Resource Center, the NTSS will provide NCSOCRC staff technology training and assistance for people with a variety of difficulties and disabilities that affect computer use. Another program the NTSS will initiate between member centers will be an informational technology program held quarterly. These forums provide an opportunity for staff to share with others throughout the country.

Assisting Persons with Disabilities...Obesity

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Assisting Persons with Disabilities to Conquer Obesity and Obtain Healthy Lifestyles

Protocol No.: **05-TATTR212-05**

Date: February 2, 2007

Protocol Title: Assisting Persons with Disabilities to Conquer Obesity and Obtain Healthy Lifestyles

Principal Investigator: Eric S. Muncert

Abstract:

Obesity is an abnormal accumulation of body fat, being more than 20 percent above ideal body weight, frequently resulting in an impairment of health (National Institute of Health, 2001). Assisting Persons with Disabilities to Conquer Obesity and Obtain Healthy Lifestyles is a pilot research study designed to educate obese students with disabilities about proper nutrition and healthy living habits that could decrease body mass weight and improve the student's mental health and academic performance. Students who experience problems such as anxiety, sadness, low self-esteem, and anger, as well as score lower grades on standardized tests could achieve success in weight loss. The National Telerehabilitation Service System (NTSS) will partner with the Hiram G. Andrews Center (HGAC), in Johnstown, Pennsylvania. The Allied Health Division within HGAC will assist in the implementation of the proposed twelve week telehealth research project that will commence in January 2007. Certified nutritionists and physical therapists from the Center will assist in educating and instructing the students. The pilot research study is designed to assist in the development of a life skills course initiated at HGAC for students who desire to improve their health through education and nutrition. Monitoring of the student's progress in body mass weight reduction, as well as blood pressure levels, will be tracked using telerehabilitation technology and the LifeSource Weight Diary and Blood Pressure Diary software. Telecommunications and computing technologies will be used to enhance the education between the student and a professional instructor or licensed healthcare provider.

Introduction/Background:

What is obesity? Obesity is a disease that affects nearly one-third of the adult American population (approximately 60 million people). The number of overweight and obese Americans has continued to increase since 1960, a trend that is not slowing down. Today, 64.5 percent of adult Americans (about 127 million people) are categorized as being overweight or obese. Each year, obesity causes at least 300,000 excess deaths in the United States and healthcare costs of American adults with obesity amount to approximately $100 billion (American Obesity Association, 2005). Among adults with disabling conditions, 24.9% were obese compared to 15.1% among those without disabilities. People with lower extremity mobility difficulties were most likely to be obese (Weil, et al. 2002).

We all have and need fat tissue in our bodies. However, when there is too much body fat, the result is obesity. Obesity is a serious medical disease that affects over a quarter of the adults in the United States. It is the second leading cause of preventable death after smoking. Obesity increases the risk of developing conditions such as high blood pressure, diabetes, heart disease, stroke, and cancer of the breast, prostrate, and colon. There is a tendency toward obesity from lack of physical activity combined with high-calorie and low cost foods. If maintained, even weight losses as small as 10 percent of the body weight can improve an individual's health.

Obesity can be a condition secondary to primary developmental disability and is an example of a condition that can lead to subsequent limitations. While to date little research has been done to show the same result in adults with developmental disabilities, there is no information that indicates a different effect. Obesity can affect the quality of life through limited mobility and

decreased physical endurance as well as through social, academic, and job discrimination. For a population at risk for decreased mobility and physical endurance already, further stress on those quality of life indicators through obesity has an even greater potential impact (Surgeon General Call to Action, 2002). Obesity in persons with developmental disabilities is attributed to behavioral factors such as inappropriate eating practices and limited mobility though environmental factors contributing to high rates of overweight and obesity in the general U.S. population may be important as well (ADA Position Paper, 1997). Persons with developmental disabilities are at an increased nutritional risk because of feeding problems, drug-nutrient interactions, metabolic disorders, decreased mobility, and altered growth patterns. In addition, they may also be at risk due to insufficient income, limited nutritional knowledge, and/or caregivers who may not provide an environment that promotes the intake of a nutritionally adequate diet.

Is obesity a disability? The Americans with Disabilities Act (ADA) provides that employers covered by the statute may not discriminate against a qualified individual with a disability with respect to employment matters. The ADA also requires public facilities and agencies to provide reasonable accommodations for people with disabilities. "Reasonable accommodations" are defined as modifications to policies, practices, and procedures that will allow services to be provided to persons with disabilities. One type of claimed disability that is increasingly the subject of litigation is obesity. Although courts initially were reluctant to recognize obesity as a qualifying disability for purposes of ADA protection, courts are increasingly willing to consider obesity as a disability, giving plaintiffs status to raise ADA claims (ADA, 1990).

This research proposal is testing the computing technologies that monitor student activities to reduce body mass weight. This study uses telerehabilitation technologies to allow physical therapists, recreation therapists, instructors, and nutritionists the opportunity to educate students about the importance of maintaining an appropriate body mass index (BMI) to assist in preventing additional developmental disabilities. BMI, although a new term to most people, is the measurement of choice for many physicians and researchers studying obesity. BMI is a mathematical calculation used to determine whether a patient is overweight. BMI is calculated by dividing a person's body weight in kilograms by their height in meters squared (weight [kg] height $[m]^2$) or by using the conversion with pounds [Weight (lbs) $\div$ height $(in)^2$] x 704.5 = BMI. (American Obesity Association)

Students may be able to identify the effectiveness of nutrition and education that hopefully improve the quality of life for them. Technology can be used to enhance the education between the student and instructor or healthcare provider. This study will monitor the effectiveness of supplementing conventional education on nutrition and healthy living with telehealth technology.

It is believed that the use of weight management software applications, in conjunction with well-being and nutrition education, will maintain or decrease the BMI of obese persons with disability.

Methods and Materials:

The research is to determine if students will be able to identify the effectiveness of nutrition education and healthy living education, which will hopefully improve the quality of life for them. This study uses computer technologies to allow physical therapists, recreation therapists, and instructors, nurses, and nutritionists the opportunity to educate students in the importance of

maintaining an appropriate BMI to assist in preventing additional developmental disabilities. The research study is to test the computing technologies that monitor student activities to reduce body mass weight. Blood pressure will be measured each week using an A & D Medical Blood Pressure Monitor. BMI will be measured each week using Spenser Bod-E Comm XL Body Weight and Body Fat Meter. A wheelchair accessible Detecto weight scale will measure body weight during the program. Data collection will be entered into the A & D Medical Blood Pressure and Weight Diary software program. Professional nutritionists, physical therapists, registered nurses, and other guest speakers will use telecommunications and computing technologies throughout the program to assist them in educating students. Subjects participating in the study must be 18 years or older and students from HGAC. HGAC provides services to people with disability, offering a comprehensive program of services that integrates education, counseling, evaluation, and therapy in a barrier-free environment. Subjects will be invited to attend a free informational program to learn about a new Nutrition/Healthy Living Education Program to begin in January 2007.

The resident population at the Hiram G. Andrews Center averages 255 clients. It is anticipated that 10%, or 25 clients, will agree to participate in the pilot study. Of the 25 participants, it is anticipated that 20%, or 5 clients, will not meet the inclusion criteria or will not complete the twelve week study. A convenience sample of twenty participants will be obtained from the study body of HGAC.

Key Research Accomplishments:
The anticipated accomplishments from this research include:

- Assess the ability of the participants to input their data into the software applications.
- Maintain or decrease BMI of participant population.
- Assess the use of software applications as evidenced by the amount of data recorded by the participants.
- Assess the ability to utilize email/server applications into future expansions of this study.
- Assess the ability to incorporate email/server applications into future applications of this study.

Reportable Outcomes/Research Results:
The research was not initiated during 2006. Approval from USAMRMC Human Subjects Research Review Board (HSRRB) IRB was received September 1, 2006. Approval from Saint Francis University's Institutional Review Board was received September 6, 2006. The fall 2006 term at HGAC ended on December 22, 2006. There was an insufficient amount of time to complete the research. It is anticipated that the protocol will begin in January 2007. The timeline to reach the milestones and deliverables is:

- Stage I: 2 weeks
  The NTSS, HGAC's Allied Health Care, and a professional nutritionist and physical therapist from HGAC will develop a twelve week life skills program agenda for students who are obese and have a disability.

- Stage II: 3 weeks

The NTSS and HGAC's Allied Health Care will develop and distribute a flier announcing the life skills program. This recruiting tool will be distributed to all HGAC students via their personal mail box at HGAC. Recruiting fliers will be distributed to all HGAC students (Appendix A).

- Stage III: 4 weeks
  Invite all interested students to a meeting. Review the informed consent, inclusion and exclusion criteria, and explain the monitoring and measurements that will be taken by a registered nurse during the study. Explain the outcomes desired by their participation in the program. Review program agenda with students. Establish personal goals with each student participating in the program during the twelve week testing period. (Appendix B)

- Stage IV: 5 weeks
  Introduce the students to the technology that will be used, the registered nurses, the nutritionist and physical therapist who will be assisting with the program. Take initial BMI and blood pressure measurements. Review the program agenda for the next meeting and review personal goals established by the student. This assessment will be completed by the registered nurse and the student.

- Stage V: 6 – 16 weeks
  Continue recording BMI and blood pressure measurements for the remainder of the twelve week research period. Throughout this period, professional nutritionists, physical therapists, registered nurses, and other guest speakers will provide information to the students throughout the program.

- Stage VI: 16 weeks
  Conclude the twelve week research program. Participants to complete survey

- Stage VIII: 23 weeks
  Develop a report delineating the effectiveness and outcomes obtained and evaluate the reliability and significance of the computing telehealth technologies used.

Conclusions/Discussions/Lessons Learned:

This pilot research study seeks to determine that through education and the monitoring of the BMI of persons with disabilities, the risk of obesity becoming a developmental disability can be reduced and does not precipitate secondary conditions such as diabetes, heart disease, and hypertension. In addition, students will be able to identify the effectiveness of nutrition and education to improve their quality of life. Technology will be used to enhance the education between the student and instructor or healthcare provider. This study will monitor the effectiveness of supplementing conventional education on nutrition and healthy living with telehealth technology.

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Extensions/Stretch Goals:

If the present research study proves successful, the program will be shared with eight additional member facilities of the National Consortium of State Operated Comprehensive Rehabilitation Centers located throughout the United States. These comprehensive rehabilitation centers must overcome geographical obstacles to provide services to large rural areas of their state, serving the needs of their clients, ranging from evaluations to medical services to educational programming in rural and medically under-served areas throughout the United States.

Casualties of War

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Telerehabilitation Support Services for Returning Casualties of War

Protocol No.: **05-TATTR213-05**

Date: February 2, 2007

Protocol Title: Telerehabilitation Support Services for Returning Casualties of War

Principal Investigator(s): Brenda Guzic

Abstract:
Preliminary congressional studies and personal interviews have indicated that there may be insufficient housing at military bases and hospitals across the country to house reservists and guardsmen on medical hold, and a severe shortage of doctors to treat them, other military personnel, and their families. These studies, in addition, suggest that the shortage of medical personnel has resulted in long delays in receiving care, and the problem is further compounded by injured or ill military personnel being housed in barracks inappropriate for their medical conditions.

The intent of this project was to study the impact of using telecommunications technology in providing rehabilitative services to injured service members returning from war. Potential partners for this study were identified to include military reserve, National Guard, and active duty service members, the National Consortium of State Operated Comprehensive Rehabilitation Centers (NCSOCRC) located in Arkansas, Georgia, Kentucky, Maryland, Michigan, Pennsylvania, Tennessee, Virginia, and West Virginia, and Dr. George Zitney of the Laurel Highlands Neuro-Rehabilitation Center.

Introduction/Background:
Recent military mobilizations and deployments of troops have resulted in large numbers of military personnel sustaining potentially debilitating injuries. As a result, the study of telerehabilitation has never been more relevant. Many of these injuries are extremely traumatic in nature and range from limited mobility and loss of an entire limb, to traumatic brain injury. Returning injured often face the possibility of grueling rehabilitation and adaptation to a life that is different than the one they left behind. Thousands of U.S. troops returning from Iraq and Afghanistan with physical injuries and health problems are encountering an overburdened benefits system, and officials worry that the challenge could grow as the nation remains at war (The Miami Herald, 2004). According to the U.S. Army, there have been over 13,263 medical evacuations from Iraq since the beginning of combat operations in March 2003, and six percent of those were for psychiatric reasons (Army Medical Department, 2004).

Many service members survive armed conflict without being physically wounded and they often return to daily life free of health complaints. Previous wars have shown us that soldiers can survive war without physical trauma and yet suffer psychological trauma that is no less debilitating than an injury from a bullet or a bomb (House Armed Services Committee, 2004). The rise in psychological trauma associated with the war in Iraq should not surprise experts. The extent of wartime trauma is directly proportional to the type of warfare fought and the experiences encountered. Studies of Vietnam Veterans show that between 26 and 31 percent have experienced Post-Traumatic Stress Disorders (National Center for PTSD, 2004). According to the United States Department of Veterans Affairs approximately 38% of Vietnam veterans' marriages failed within 6 months of the veteran's return. The overall divorce rate among Vietnam veterans is significantly higher that the general population and rates are even higher for veterans with PTSD. The National Vietnam Veterans Readjustment Study (NVVRS) found that divorce rates for veterans with PTSD were two times greater than for veterans without

PTSD. In addition, according to the National Center for PTSD (2006), studies have found that families of veterans with PTSD have more family violence, more physical and verbal aggression, and more instances of violence against a partner

When a service member is injured while deployed in support of an operation such as Operation Iraqi Freedom or Operation Enduring Freedom, the process from point of injury to treatment depends on the severity of the injury and availability of medical treatment. On a traditional battlefield, the service member would be treated by a combat medic initially and then transported to an aid station where the treatment available would include emergency medical treatment, advanced cardiac life support (ACLS), and stabilization for further evacuation. Also available on a traditional battlefield may be a group of surgical specialists called a Forward Surgical Team. The team is capable of ACLS and stabilizing major trauma emergencies for further evacuation. The next step in available treatment in a deployed location would be to a "field-type" hospital called a Combat Support Hospital.

The current evacuation policy requires that an injured service member must be either treated and returned to duty within 72 hours or evacuated out of "theater" within that timeframe. For the current operation, this means evacuation to a garrison (established stationary); military medical treatment facility (MTF), usually in Germany. If the injury is such that the service member cannot be returned to duty and requires extended rehabilitation, the service member is then returned to the United States to an MTF such as Walter Reed Army Medical Center (WRAMC) or Bethesda Naval Hospital.

For a military reservist or national guardsman, the rehabilitation time spent at WRAMC or Bethesda could be significantly shortened by utilizing a telemedicine rehabilitation option. Tele-rehab centers could be established at key locations around the state and nearer to the service member's home, allowing the service member to return home to family and friends and a much larger support network than is available to them at WRAMC or Bethesda. The National Telerehabilitation Service System (NTSS) plan was to examine the above listed protocol and determine where telerehabilitation and technology could best assist service members in returning home.

The NTSS is an initiative to capitalize upon the extremely successful results of a collaborative "proof-of-concept" telerehabilitation research study carried out by Saint Francis University's Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA), with the Hiram G. Andrews Center (HGA), located in Johnstown, Pennsylvania. The NTSS is an alliance of researchers, service providers, and technologists who improve accessibility to quality comprehensive rehabilitation services for people with disabilities through the application of sustainable technologies and applied research.

The NTSS and CERMUSA have access to the technology which is extremely relevant to the returning wounded; rather than remaining in a hospital, many guardsmen could return to their homes for healing and recovery while being remotely monitored by medical staff and allied health professionals who have been specifically trained to deal with these types of injuries. The NTSS and CERMUSA hoped to be able to achieve this goal through the use of technology and telerehabilitation. The Navy is already utilizing a similar type of technology at the National Naval Medical Center (NNMC); "NNMC was the first military medical facility to install and incorporate video teleconference (VTC) communication into its healthcare," said Eric Ewers,

telemedicine coordinator and VTC technician. The extension of the hospital enhances medical care by incorporating VTC technology into different departmental clinics that reach a multitude of patients, in-house and fleet-wide (The Journal, 2004).

Hypothesis:
The use of telehealth technologies can cost-effectively enhance recovery and improve the quality of life of military casualties.

Objectives:
- Develop a comprehensive plan to initiate a telerehabilitation demonstration program to support military war casualties.
- Examine methods to expedite the physical and mental recovery of military reserve, National Guard, and active duty service members.
- Identify ways to reduce the amount of time spent on medical hold for the above listed individuals.

Technical Objectives:
- Can a telerehabilitation demonstration program be of benefit to military war casualties?
- What are the best telehealth methods to assist the physical and mental recovery of service members?
- Is it possible to reduce the amount of time a service member spends on medical hold at a military hospital?

Methods and Materials:
The goals of the project were for the NTSS to create a plan to initiate a demonstration project that would show how telehealth and telerehabilitation technologies could be used to expedite recovery from physical wounds and mental health conditions, increase the morale of returning war casualties and their families, and expedite administrative procedures.

The methods and materials utilized to reach the above goals included:
- Meetings with local, regional, and national military organizations and personnel
- Presentations to local, regional, and national military organizations and personnel
- Telephone, email and written communications with local, regional, and national organizations and personnel
- Examination of Veterans Affairs reports related to returning war wounded

In addition, in 2005 the NTSS enlisted the support of retired SGT. Major Sam Allison to assist in information collection. SGT. Major Allison is extremely involved with local and regional military units. On a monthly basis he meets with the units and their prospective officers to discuss current issues and needs. He was provided with information sheets outlining the proposed telerehabilitation support services for returning casualties of war as well as contact information to distribute to any personnel that he felt was appropriate. The above efforts continued into 2006 and included additional networking with local and regional government and military officials and contact with Dr. George Zitney, Director of the Laurel Highlands Neuro-Rehabilitation Center, a new military related brain-injury treatment center that is scheduled to open in Johnstown, PA in 2007.

It was determined that this study could be accomplished by utilizing video-teleconferencing technology (VTC), technology that could be installed at the military hospitals and selected reserve centers; in addition, the NTSS has VTC equipment currently installed at the nine NCSOCRC throughout the United States that can be utilized for additional links. There are some reserve centers that already have rooms dedicated to distance learning; this would have allowed for even more links for family members to utilize. The family members would have been able to drive to any of these links for scheduled VTC sessions with their loved ones; this would have permitted the casualties to see their family members rather than writing letters or talking over the phone. As a side benefit, the family members would have noticed a cost-savings in utilizing the VTC links; the savings would have been a result of less travel time, less gas expenditures, decrease loss of wages from extra time off from work, and fewer meals while traveling.

The appropriate clinical assessments and research interventions would have been determined by the military hospital or medical doctor. One possibility could have been increasing morale for wounded service members by connecting them to their loved ones via telecommunications technologies while they were rehabilitating at a military hospital. Many times these soldiers require extensive rehabilitation prior to discharge; connecting them to their families would have helped to decrease depression/anxiety as well as recovery time.

Key Research Accomplishments:
Due to the delay in securing a partner to collaborate with on this project, study was not initiated.

Reportable Outcomes/Research Results:
The intent of this study was to collect data utilizing a qualitative method over a predetermined period of time within a Telehealth environment.

All participant information would have been kept confidential. A master code database to link personal patient identifiers to the patient's study code number would have been kept. This code would not have contained any part of the patient's social security number. This link would have been kept in a locked file in a designated secure place in Saint Francis University's CERMUSA office. The link between the patient identifying information and the study code would have been destroyed seven years after completion of the study.

Initial recruitment was to focus on injured service members that had returned to a military hospital in the United States. The military hospitals and/or physicians would make a referral for participation in the Telehealth study if they determined the soldier to be appropriate.

For those individuals indicating their willingness to participate in this study, an informed consent would have needed to be completed prior to utilizing the telehealth technology. One of the military partners would have explained the informed consent to the participant; the participant would have been encouraged to ask questions prior to signing the form. If the participant had decided to proceed and had demonstrated an understanding, they would have signed two copies of the consent in the presence of the military partner and a witness. A copy would have been provided to the participant. If subjects had wanted the equipment but had not wanted to participate in the study, eligibility would have been determined by the military partners and the NTSS, with consideration of the appropriateness of the situation and the availability of equipment.

All subjects identified as potentially benefiting from a telehealth environment would have had the opportunity to utilize the technology. There would have been no required screenings or evaluations to determine eligibility or suitability for this study. There would have been no random assignment; all participants would have been eligible based on military physician determination. It should be noted that subjects also had the right to decline participation without fear of reprisal.

Participants would have completed a survey prior to their initial use of the technology and at the end of each session until they were no longer utilizing the technology. Surveys would have been completed and returned to the NTSS for tabulation and kept on file at CERMUSA. Surveys and informed consents would have been available at each location where the technology was installed; the staff at each center would have been responsible for collecting the forms and returning them to the NTSS. The appropriate clinical assessments and research interventions would have been determined by the military hospital or medical doctor.

A possible utilization of the technology that was identified was in the area of service member morale. Morale of both the service members and their families could have been increased by connecting war casualties to their loved ones via telecommunications technologies while they were being rehabilitated at a military hospital. Many times these soldiers require extensive rehabilitation prior to discharge; connecting them to their families could help to alleviate depression/anxiety and may result in a decreased recovery time. This connection could have been accomplished via VTC technology that would have been installed at the military hospitals and selected reserve centers; the NTSS also has VTC equipment currently installed at the nine NCSOCRC throughout the United States that could have been utilized for additional links. There are some reserve centers that already have rooms dedicated to distance learning; this would have allowed for additional links for family members to utilize. The family members would have been able to drive to any of these links for scheduled VTC sessions with their loved ones; this would have permitted the casualties "to see" their family members rather then writing letters or talking over the phone. Additionally, the family members would have noticed a cost-savings in utilizing the VTC links; the savings would have been a result of less travel time, decreased gas expenditures, reduction in time away from work, and fewer meals while traveling.

The VTC equipment could also have been utilized in another venue; the military could have used the equipment to assist in conducting medical boards. After a soldier has been wounded and sent to a military hospital, a medical board convenes to review and discuss the service member's case. They evaluate and decide whether the service member is fit to return to active duty or should be discharged due to his/her medical condition. VTC equipment would allow soldiers to return home to their family instead of waiting at the crowded hospital for the medical board to convene. Conducting medical boards over VTC would save both the service member and the board members time, travel, and boarding costs; the service member and board could travel to one of the VTC units mentioned above instead of traveling to the hospital.

Another arena to be investigated utilizing the VTC equipment would have been connecting returning war casualties and their treating physicians or hospitals to the military hospitals. This would have given soldiers the opportunity to return home earlier because they could be connected to the military hospitals through VTC and the staff at the military hospital could still contribute to the service member's medical plan of care. Psychologists could have provided counseling through the videophones or VTC on issues such as depression and anxiety from war

related stress and physicians and allied health professionals would have been able to monitor activities of daily living, medication compliance, and changes in signs and symptoms.

The data analysis would have examined the completed surveys from service members and medical personnel who were involved in the telehealth evaluations. The NTSS would have collected information from the different types of evaluations completed to determine which yielded the highest results.

Conclusions/Discussions/Lessons Learned:

After much discussion and research, the NTSS determined that a protocol to assist the returning war casualties could be created utilizing a telehealth environment. The NTSS held several discussions and presentations with local and regional units to determine the needs of the returning war casualties. Responses to these meetings were positive, and NTSS did uncover a number of issues.

It was discovered that many military personnel were reluctant to provide the NTSS with information regarding "what they felt they needed." It appeared they did not want to be the ones "pointing the finger" at the military. It also appeared that some of those interviewed were "just not ready" to talk. The combat experience was too recent and all they wanted was to return to their families. Another issue was that many of the higher ranking officers were deployed and unavailable for interview. When discussing our proposal with the units, many of the staff felt that the NTSS had good ideas, but none of the staff had the authority to make a decision as to initiating a project.

Despite encountering a few obstacles and some "dead ends," we were still able to identify potential avenues of intervention and utilization via a telehealth environment that could be of benefit to the returning war casualties; conducting clinical assessments, increasing patient and family morale, interdisciplinary patient conferences, and administrative meetings. Unfortunately, due to the lack of partnerships, we were unable to move forward with our project. It is apparent from our needs assessment that such intervention is required. However, it is not clear why there is unwillingness to accept that such intervention is needed "now", more so than later

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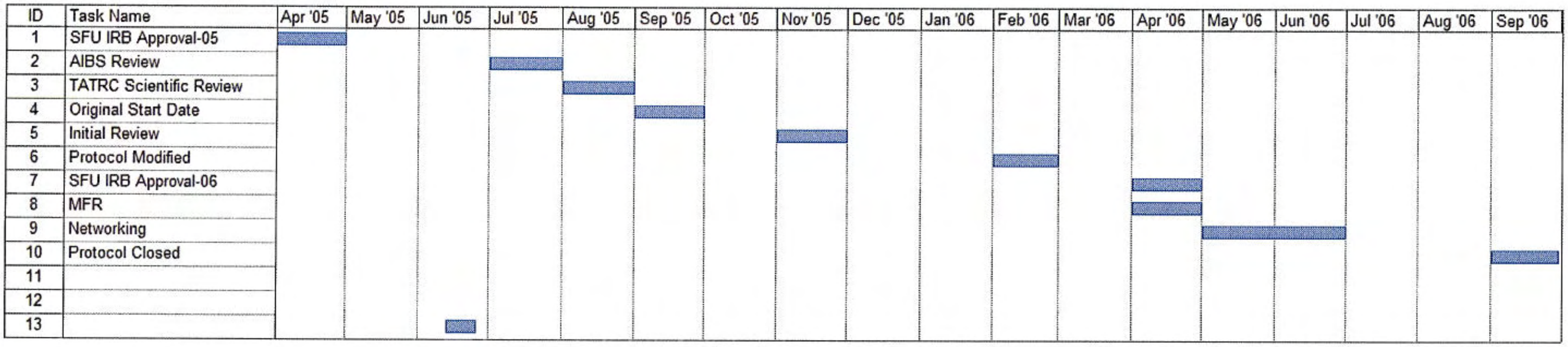
Extensions/Stretch Goals:
Due to the inability to secure partnerships, this study has officially been closed.

Supporting Data:

Casualties of War
Timeline



Utilizing “Off Center” Robotic Neuro-Rehabilitation

Saint Francis University
Center of Excellence for Remote and Medically Under-Served Areas (CERMUSA)

Annual Report

Protocol Name: Utilizing "Off Center Robotic Neuro-Rehabilitation to Assess Kinematic Relearning in Upper Extremity Deficits after Stroke

Protocol No.: **05-TATTR214-05**

Date: February 2, 2007

Protocol Title: Utilizing "Off Center" Robotic Neuro-Rehabilitation to Assess Kinematic Relearning

Principal Investigator: William DeMayo MD, John P. Murtha Neuroscience and Pain Institute (JPMNPI)

Abstract:

Despite having several evenly distributed stroke centers located in southwestern Pennsylvania, many patients live in exceptionally remote areas of the state (Pennsylvania Department of Health, 2003 and Pennsylvania State Data Center, 2002). This creates a challenge for the non-institutionalized stroke survivors; they often cannot obtain essential outpatient physical therapy because of barriers such as transportation. Education and research are two very important ways to help improve the morbidity and mortality rates associated with strokes.

After a disabling injury such as stroke, many people seek rehabilitation therapy. This imposes a substantial challenge in rural under-served areas, which have fewer healthcare workers to serve patients with a disability. Therefore, alternative healthcare delivery models utilizing technology may fill the void in rehabilitative healthcare resources and community needs. These alternative delivery methods must explore technology options, clinical outcomes, patient acceptance/fear of the therapy, and reimbursement components.

The modern approach to the treatment of stroke has appropriately focused on prevention and acute management. However, prevention does not work for all (American Heart Association, 2004), and new pharmacology for acute management has practical limitations, so that there has been a revival in developing new treatment strategies for post-stroke recovery. The theme of current research into recovery from brain injury, that activity-dependent plasticity underlies neuro-recovery, motivates the attempt to alter stroke outcome by properly targeted sensori-motor activity controlled by novel robotics.

This research project attempts to explore the viability of using the InMotion2 Shoulder-Elbow Robot (IM2) to deliver therapy to patients living in remote locations. The objectives will be: to evaluate sensori-motor recovery using a robotic training device in an "off-center position" in subjects with at least one year history of hemiparesis due to stroke and to demonstrate a relationship between a sensori-motor evaluation with a robotic unit and conventional neuromuscular assessment.

Introduction/Background:

Stroke is a leading cause of disability in the United States and, as the population continues to age, this will continue to be the case. The following facts from two major stroke organizations make the impact of stroke quite clear:

According to the American Stroke Association (2004):

- Stroke is the third leading cause of death in the United States and is expected to consume 53.6 billion healthcare dollars in 2004 for direct and indirect costs.
- Statistics indicate that nearly 700,000 Americans suffer from new or recurrent strokes each year, and approximately 4.8 million stroke survivors are alive today.
- The estimated number of non-institutionalized stroke survivors increased from 1.5 million in the early 1970's to 2.4 million in the early 1990's.
- Stroke rehabilitation strives to assist these stroke survivors to reach the highest level of independence and productivity possible.

According to the National Stroke Association (2002):

- Approximately 40% of stroke victims experience moderate to severe impairments requiring special care, 25% of stroke victims retain minor impairments, and 10% of the victims experience a near complete recovery.
- Although many functional abilities may be restored soon after a stroke, recovery is an ongoing process.

Stroke survivors in remote or medically under-served areas of the state are faced with a variety of obstacles in accessing care. In addition, rehabilitation facilities are forced to seek alternative approaches to patient care as a result of the Prospective Payment System (PPS), a reimbursement structure enacted in January 2002. Inpatient rehabilitation options are severely restricted and, when available, lengths of stay are significantly shorter than in the past. Consequently, stroke rehabilitation goals are shifted to outpatient rehabilitation centers or the home setting. This imposes an even greater challenge in rural under-served areas, which have fewer healthcare workers to serve patients with a disability (Scheideman-Miller, Clark, Moorad, Post, Hodge, & Smeltzer, 2002). These innovative delivery methods must explore technology options, clinical outcomes, patient acceptance/fear of treatment, and reimbursement issues (Scheideman-Miller et al., 2002). One example of such a program is in place at The Shephard Rehabilitation Center in Atlanta, Georgia. This state-of-the-art center uses telemedicine connections with outpatients to monitor the healing of pressure ulcers, to assist newly injured clients with psychological adjustments, to evaluate and recommend changes to the home, to identify needed changes to equipment, and to evaluate individuals with acquired brain injuries (Advance for Occupational Therapy Practitioners, 2002). It has proven that innovative healthcare delivery models utilizing technology can help to fill the void in rehabilitative healthcare resources.

Many research facilities are investigating the use of robotics to provide rehabilitative treatment to disabled individuals. Stanford University's Dexterous Manipulation Laboratory is utilizing a dexterous robotic hand to enable the user to interact with the environment from a remote location (Stanford University Mechanical Engineering Research Laboratory, 2002). Rutgers University is investigating the use of a virtual-reality haptic (force) interface utilizing a robotic ankle that allows patients to interact with virtual environments as they exercise (Rutgers University, 2001).

Several universities are currently utilizing a robotic unit called the IM2 created by Interactive Motion Technology Services, Inc. This device is capable of providing rehabilitative therapy to individuals with upper extremity impairments. Similar prototypes could have a profound effect in treating individuals recovering from neurological conditions such as stroke. Studies involving the use of the IM2 robotic unit have demonstrated statistically significant increases in motor power and motor status scoring up to 6 months following robotic interventions (Fasoli, Krebs, Stein, Frontera, & Hogan, 2003 and Volpe, Krebs, & Hogan, 2003). One such study was conducted by the Massachusetts Institute of Technology utilizing 20 persons diagnosed with a single, unilateral stroke within the past 1 to 5 years, with persistent hemiparesis. Evaluations by a single blinded therapist revealed statistically significant gains from admission to discharge for all participants that were able to complete the study. To date, studies have been performed in the midline of the body. Observations indicate performances of the protocols are more difficult from an "off-set" (away from the center of the body toward the affected side) position and researchers have theorized the off-set position may result in even greater motor sensory recovery. The primary goal of our study is limited to demonstrating the effectiveness of the off-center position; however, future studies may compare off-center position results with midline position results.

Future research opportunities may also include evaluation and treatment from remote settings. The IM2 has demonstrated the potential to be used over the Internet. Its novel design allows for complex movements of the upper extremity as well as remote haptic feedback. In a web-based study of java applications for robotic control in a home setting, it was suggested that robotic intervention also had a direct impact on depression and independence in stroke survivors

(Reinkensmeyer, Pang, Nessler, & Painter, 2002). This study was limited by its use of "off-the-shelf" equipment which is restricted to utilizing motion at the wrist with a joystick or mouse. We feel the use of the IM2 via the Internet should produce similar results.

The IM2 affords an ideal opportunity to incorporate virtual reality with haptic feedback to provide rehabilitative therapy via the Internet. The technology is currently in place to use the IM2 remotely – establishing the possible future treatment of stroke patients in the home or in a rural clinic far from a stroke professional (Olsson, Carignan, & Tang, 2004).

Methods and Materials:
An IM2 Robot user group was convened to explore potential research opportunities utilizing the IM2 Robot. The IM2 Robot user group consisted of members from the following organizations:

- Georgetown University's Imaging Science and Information System (ISIS) Center
- John P. Murtha Neuroscience and Pain Institute (JPMNPI)
- Massachusetts Institute of Technology (MIT)
- National Telerehabilitation Service System (NTSS)
- Interactive Motion Technologies
- Center for Applied Biomechanics and Rehabilitation Research, National Rehabilitation Hospital

Several meetings were held and the following areas were addressed:

- Therapy using haptic feedback
- Cooperative rehabilitation using a Shared Virtual Environment
- Past successes of the IM2 Robot in the midline position
- Potential benefits of "off-center" utilization
- Demonstration of equipment
- Training of the JPMNPI and NTSS staff

Based upon the information shared among members of the group, the level of professional expertise of the group members, past successes of the IM2 Robot, and an identified need to provide an alternative treatment modality for stroke survivors, the decision was made to proceed with the pilot study.

This will be a pilot, self-controlled prospective study involving thirty-six subjects previously diagnosed with a single cerebral or basal ganglia stroke verified by CT or MRI. The subjects will act as their own "built in" control (six week waiting period v. six week intervention).

The goal for this research is for the NTSS to collaborate with Georgetown University's ISIS Center and the JPMNPI, located in Johnstown, Pennsylvania, to examine the feasibility and relevance of using robotics and computing technologies to deliver outpatient rehabilitative therapy.
Initial recruitment will focus on stroke survivors more than one year post discharge from Memorial Medical Center (MMC), located in Johnstown, Pennsylvania. These candidates will be mailed an informational flier by the Crichton Rehabilitation Center located in Johnstown, PA. Failure to recruit thirty-six participants through this method will result in an expansion of recruitment to include referral by physicians as well as direct recruiting via advertisements to the general population. Patients who express initial interest will be mailed a letter inviting them to an information session to explain the scope of the study. Potential participants may indicate at that time their willingness to participate in the study (the choice is always theirs). Eligible individuals will be scheduled for clinical evaluation with the Principal Investigator (PI) to confirm that remaining inclusion/exclusion criteria are satisfied.

Eligible and willing individuals will have an opportunity to review the informed consent with the study coordinator. They will be invited to meet with the study coordinator to review the informed consent in detail. The participant will be encouraged to ask questions and his/her understanding will be documented on a Statement of Understanding. If they decide to proceed and have demonstrated an understanding, they will sign the informed consent, medical records release form, and the Health Insurance Portability and Protection Act (HIPPA) release form in the presence of the study coordinator and a witness. This informed consent process will occur prior to any participation in the protocol.

This study will utilize an electrically driven robotic device (IM2) which is listed with the FDA both as an evaluation device (890.1925) and as a therapy device (890.5380). This robotic device is capable of exerting approximately five pounds of force at the handle in each direction. Since it can attain high speeds if released, a number of software safety systems are in place to prevent uncontrolled motion or allow forces to exceed hardware limits. In addition, two independent emergency stops are within easy reach of the experimenter and the participant, and "bumpers" are in place to keep the handle of the robot within the confines of the work area.

To minimize any potential risk of injury, multiple levels of protection are built into the machine. In the event of a malfunction, the servo-amplifiers are disabled within a few milliseconds, removing power from the motors. Machine malfunctions are detected in several ways. Excessive speed, acceleration, and force exerted are detected by the controlling software and result in disabling the system. An independent electronic circuit monitors the motion of the robot, the availability of electrical power, the health status signal from the servo-amplifiers, the health status signal from the encoders, and the status of two human-operated "kill-switches." Software failure, motion beyond a specified range, loss of electrical power, or activation of the switches all shut down the robot. During all robotic interventions, a trained member of the research team will be present. Prior to beginning the study, participants will be made aware of potential risks and safety precautions. It is important to note that an earlier model of the IM2 Robot has been used in clinical trials at the Baltimore Veteran Affairs Hospital for two years without incident, and current models incorporate additional safety features (MacClellan LR., Bradham DD., et al. 2005).

Plan:

a. **Number of Subjects to be Studied:** 36

- Rational for sample size

CONSORT guidelines require an a priori justification of sample size. A research study with good power is normally able to detect a change whenever the treatment is indeed effective. The actual calculation of power requires three pieces of information. These pieces are the research hypothesis, the variability of the outcome measure, and an estimate of the clinically relevant difference. In this study of robotic sensitivity for stroke survivors, we are interested in seven continuous measures:

- Mental State
- Depression
- Pain and Strength
- Motor Status
- Motor Power
- Spasticity
- Shoulder Stability

This study will utilize 4-point, 6-point, and 10-point measurement scales. A review of previous studies using these scales shows a trend for a standard deviation of 1.5 units. Therefore, to

obtain a power of 0.80 and a probability of type II error of 0.20 for these two independent groups, the following formula is used:

$$n = \frac{(SD^2 + SD^2) \times (Z_{1\text{-alpha}/2} + Z_{1\text{-beta}})^2}{D^2}$$

Where:
n = sample size
SD = standard deviation = 1.5
Z = standard normal deviation
Alpha = probability of Type I error (0.05)
1-alpha/2 = 1-0.05/2 = 1-0.025 = .975
z = 1.96 from table
1-beta = 1-0.02 = 0.80
z = 0.84 from table
Beta = probability of Type II error (0.05-0.20)
D = clinically relevant difference = 1

Substituting:

$$n = \frac{(1.5^2 + 1.5^2) \times (1.96 + 0.84)^2}{1^2} = 35.3$$

Therefore, in order to achieve 80% power for detecting one unit difference in the scores, which has a standard deviation of 1.5, it will be necessary to sample 36 patients, serving as self-controls.

Inclusion and exclusion criteria:

Inclusion Criteria:

1. Age 18 or older and of either gender
2. Single unilateral stroke in either cerebral hemisphere (verified by MRI or CT scan)
3. At least one year post stroke
4. If there is a history of a fracture in the affected arm, it must be completely healed
5. Cognitive and language function sufficient to understand the experiment and follow instructions as indicated by a passing score on the Mini Mental State Test (24 or higher) as determined by the study coordinator
6. Motor power score of $\geq$2/5 or $\leq$ 4/5 (neither complete paralysis nor fully recovered arm function) in the affected shoulder and elbow
7. Informed written consent to participate in the study
8. The participant will have the ability to attend all sessions and complete the required documentation/instruments at the designated intervals
9. Demonstrate stable performance through 2 robotic assessments prior to initiating the intervention

Exclusion Criteria:

1. Severe muscle or joint pain (>7 on the VAS) in the affected arm
2. Incompletely healed fracture in the affected arm
3. A fixed contracture deformity in the affected limb which limits ability to move the arm over the entire work surface of the InMotion 2

4. Inability to actively move the arm across the work surface of the InMotion 2
5. Any medical condition, which might produce a reduction in neuro-kinematic response. This will include (but not limited to) Parkinson's, Cerebral Palsy, Spinal Cord Injury, Brain Injury, Multiple Sclerosis, Sleep Disorders, or use of medication producing significant sedation
6. Depression scoring equal to or above 20 on the Beck Depression Inventory (moderate or severe depression)
7. Has had any restorative therapy to the involved extremity within the past 2 months

Baseline, stability, and post intervention data will be validated using a pair-wise comparison utilizing the 2-tail t-test. Follow-up data and robotic assessments will be compared utilizing the Analysis of Variance (ANOVA) method. The ANOVA method will allow for comparison of robotic and manual assessments.

Robotic Data Collection and Exercise:

- Robotic Evaluation Protocols will be performed in midline as well as "off-center" position (offset of 20 cm toward the affected side)
- Robotic Exercise protocols will be performed using computer protocols with an offset of 20 cm toward the affected side
- Subjects will need to complete 15 of the 18 sessions as well as the evaluations to remain in the study. Subjects will need to complete 80% of the repetitions (2048) in order for the session to be included

Other Data Collection:

- Outcome measures will be obtained using a battery of assessments as well as the Robo-kinematic Assessment. Assessments will be conducted at the following intervals:
    - Entrance into the study
    - At 6 weeks (prior to intervention)
    - At 12 weeks (the completion of the intervention)
    - At 6 months (3 month follow up post intervention)
    - At 9 months (6 month follow up post intervention)

- The assessment battery outlined below will be performed concurrently with all robotic data collection in order to allow the objective improvements noted by the robot to be compared to changes on previously standardized tests and to allow assessment of other factors such as depression or spasticity which might effect testing.

- Assessment Battery*:
    - Mini Mental State
    - Beck Depression Inventory
    - Visual Analog Scale for Pain and Strength
    - Motor Status Score
    - Motor Power Score
    - Modified Ashworth Spasticity Assessment
    - Shoulder Stability Testing

***These assessments are to confirm continued eligibility.**

Key Research Accomplishments:
Institutional Review Board (IRB) issues and satisfaction of requirements of our military oversight partners has delayed the initiation of the study. On November 30, 2006, an approval memo was received from the Human Research Protection Office, Office of Research Protection, U.S. Army Medical Research and Material Command (USAMRMC) which indicated that the subject protocol was reviewed and found to comply with applicable Federal, Department of Defense (DOD), U.S. Army, and USAMRMC human protection regulations. IRB approvals were obtained from MMC and Saint Francis University (SFU). With these approvals in place, the study will proceed as planned.

Reportable Outcomes/Research Results:
After much discussion and research, it was agreed that the NTSS and JPMNPI would undertake a conventional operation protocol as their first protocol. The goal was to allow the NTSS and JPMNPI staffs to become familiar with the robot. It was also determined that IRB approval would be easier to obtain utilizing a conventional treatment. Data collected from this pilot study could then be used as the basis for future protocols to include, but not be limited to, investigating the remote operation capabilities of the IM2 Robot.

The literature reviews indicate that most conventional research with the robotic unit has been completed with the robotic arm located at the midline of the body. Our hypothesis for our first protocol is that the use of "off center" robotic exercise in stroke survivors will increase neuro-kinematic function. The "off center" location for the robotic exercise will be located 20 centimeters away from the midline of the body towards the affected side of the client.

This study received an American Institute of Biological Scientists (IBS) review in July 2005 (#05350004). The review noted that the hypothesis is clear and concise, and the objectives further clarify the value of the study. This is expected to yield publishable information related to a new method of stroke patient rehabilitation.

Conclusions/Discussions/Lessons Learned:
The three project partners have agreed to utilize the robot in a conventional therapeutic model that incorporates a situation that has not yet been studied as their first protocol. In an effort to increase neuro-kinematic function in stroke survivors, the first protocol will be completed with subjects performing an evaluation and treatment in an off-center position.

The protocol will be a self-controlled study utilizing thirty-six participants previously diagnosed with a single cerebral or basal ganglia stroke verified by CT or MRI; they will all be wait-listed six weeks prior to the intervention.

The benefit of a technology driven healthcare delivery model is that it can potentially fill the void in rehabilitative healthcare resources and community needs. These alternative delivery methods should explore technology options, clinical outcomes, patient acceptance/fear of the therapy, and reimbursement components. This research project will explore the viability of using the IM2 robot to deliver therapy to patients.

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Extensions/Stretch Goals:

The study has not begun therefore there are no data to report. However, we hope to show that the use of "off-center" robotic exercise in stroke survivors will increase neuro-kinematic function. This device is capable of providing rehabilitative therapy to individuals with upper extremity impairments. This protocol could have a profound effect in treating individuals recovering from neurological conditions such as stroke. Two studies involving the use of the IM2 robotic unit in the midline position have demonstrated statistically significant increases in motor power and motor status scoring up to six months following robotic interventions (Reinkensmeyer, Pang, Nessler, & Painter, 2002).

Future efforts could include, but not be limited to, the following:

- Comparing "off-center" results with midline results
- Evaluation and treatment of patients from remote settings (home or rural clinic)
- Use over the Internet
- Treatment of other neurological disorders such as traumatic brain injury, Parkinson's disease, and spinal cord injury

We feel that telerobotic technologies will enhance and expedite physical and mental recovery of individuals with disabilities resulting from stroke. This product has the potential of expanding its scope to include other neurological disorders and may prove to be a viable adjunct to

treatment or a treatment alternative in areas with limited resources and/or increased community needs.